THE

EDINBURGH NEW

PHILOSOPHICAL JOURNAL.

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EDINBURGH NEW PHILOSOPHICAL JOURNAL,

EXHIBITING A VIEW OF THE

PROGRESSIVE DISCOVERIES AND IMPROVEMENTS

IN THE

SCIENCES AND THE ARTS.

CONDUCTED BY

ROBERT JAMESON,

REGIUS PROFESSOR OF NATURAL HISTORY, LECTURER ON MINERALOGY, AND KEEPER OF THE MUSEUM IN THE UNIVERSITY OF EDINBURGH;

Fellow of the Royal Societies of London and Edinburgh; Honorary Member of the Royal Irish Academy; of the Royal Society of Sciences of Denmark; of the Royal Academy of Sciences of Berlin; of the Royal Academy of Naples; of the Geological Society of France; Honorary Member of the Asiatic Society of Calcutta; Fellow of the Royal Linnean, and of the Geological Societies of London; of the Royal Geological Society of Cornwall, and of the Cambridge Philosophical Society; of the Antiquarian, Wernerian Natural History, Royal Medical, Royal Physical, and Horticultural Societies of Edinburgh; of the Highland and Agricultural Society of Scotland; of the Antiquarian and Literary Society of Perth; of the Statistical Society of Glasgow; of the Royal Dublin Society; of the York, Bristol, Cambrian, Whitby, Northern, and Cork Institutions; of the Natural History Society of Northumberland, Durham, and Newcastle; of the Imperial Pharmaceutical Society of Petersburgh; of the Natural History Society of Wetterau; of the Mineralogical Society of Jena; of the Royal Mineralogical Society of Dresden; of the Natural History Society of Paris; of the Philomathic Society of Paris; of the Natural History Society of Calvados; of the Senkenberg Society of Natural History; of the Society of Natural Sciences and Medicine of Heidelberg; Honorary Member of the Literary and Philosophical Society of New York; of the New York Historical Society; of the American Antiquarian Society; of the Academy of Natural Sciences of Philadelphia; of the Lyceum of Natural History of New York; of the Natural History Society of Montreal; of the Franklin Institute of the State of Pennsylvania for the Promotion of the Mechanical Arts; of the Geological Society of Pennsylvania; of the Boston Society of Natural History of the United States; of the South African Institution of the Cape of Good Hope; Honorary Member of the Statistical Society of France; Member of the Entomological Society of Stettin, &c. &c. &c.

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CONTENTS.

CONTENTS.

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On the Palæohydrography and Orography of the Earth's Surface, or the probable position of Waters and Continents, as well as the probable Depths of Seas, and the absolute Heights of the Continents and their Mountain-Chains during the different geological periods. By M. AMI BOUÉ. Communicated by the Author.

(Continued from vol. lv., page 316.)

BUT we give the means to determine approximatively this value by another way, so that it is possible to control this geognostic bathographic mode of determination by the more geodetic one. Another control is given us by the estimation made by Humboldt for the maximum of the medium of continental heights, and the height of the point of gravity in the volume of all continents above the present level of the sea. He was led to this by the evident errors of Laplace, who estimated 4000 feet the middle elevation of continents. Humboldt found 157·8 toises, or 307 metres, or 942 feet, for this value, but he left out of consideration and calculation the whole of Africa, where there exist immense plains, as well as very extensive plateaux, and even in the south-east very high and extensive chains. Nor could he have had, during the time of his calculation, an exact idea of the greatness and altitude of the lofty plateaux and plains of North America; and he must have overlooked also all what is called the polar countries or islands, where high chains are not uncommon, especially at the Austral pole. For that reason A. K. Johnston differs already a little from Humboldt; for he admits in Europe, instead of the 105 toises of Humboldt, 671 feet; for North America, instead of 117 toises, 748 feet; for Asia, instead of 180 toises, 1152 feet; for South America, instead of 177 toises, 1151 feet. We arrive in this way at the probability that Humboldt and Johnston's estimations are still too high; but as in our way of reasoning, we must also take into consideration all the parts of the earth's crust which form submarine protuberances, and add this value to the one admitted in continental parts above the sea level; in this way we must arrive evidently at a higher estimation of middle height or thickness, and this will not be far from 1500 to 2000 feet in height for the last wrinkled pellicle of our globe under and above the sea level, which we thought to be able to establish for our whole water-covering of the oceans.

On the other side, the values of the elevations and subsidences, or high and low parts of the earth's surface, being equal, an estimation of the maximum for the middle height of continents gives us the means to calculate the whole quantity of sea water through the mutual surface contents of land and water. The mutual relations of these is said to be about 1 : 3 or $2\frac{4}{5}$, but according to Lyell, it is 1 : 4, 1 : 3. He admits for the whole earth's surface 148,522,000 square miles, with 37,673,000 square miles dry land, and 110,849,000 square miles of water (*Principles*, 1835, vol. i., p. 216). In following Laplace's old error of giving to the middle depth of the seas 2 miles or 4 leagues (*Mem. Acad. de Sc. Paris*, 1776), we arrive at a quantity of water of 55,091,600 cubic leagues, or even for all waters on the earth's surface 110,183,200 cubic leagues of Breislak (*Institut. Geol.*, 1818, vol. i., p. 48). If Kant fixed the middle depth of seas to half a geographical mile, and Keil to a quarter of a mile, old De la Metherie was still more near the truth in admitting only 1200 to 1500 feet for this value; and by that way he was able to calculate the quantity of the sea water to 1,530,320 cubic leagues. He added also that if the whole earth's surface were flat and covered entirely with water, the depth of it would be only 700 feet, according to the admission of the mentioned value of the quantity (*Theorie de la Terre*, 1795, vol. ii., p. 347).

De la Metherie's estimation of the quantity of water must be too great, if other calculations conduct Rozet to believe that this value is 1000 times smaller than the volume of the compact parts of the globe (*Traite de Geologie*, 1835, p. 15). The volume of the whole spheroid would be, according to Breislak, 1,230,320,000 cubic leagues; according to Daubuisson, 1,079,235,800 cubic myriameters (*Traite de Geognosie*, 1819, vol. i., p. 25); and according to Reviere, 1,082,634,000. K. M. Beudant allows the quantity of the water on the globe under two millions of cubic myriameters.

When we have once the true value of the sea water and its basin, we can logically conclude from this the value of the dry land. But here is the place to remark that the highest chains are placed always

only upon the greatest protuberances or vaults of the earth's surface, which is quite natural; but together give an indication of the maxima and minima values of the elevations upon the whole globe, as well as in each country. In other words, if we find heights from 24,000 to 27,000 feet in South America and the Himalaya, or similar cavities in the Austral seas, we must not believe that there exist in the earth such a force of elevation or subsidence; but that only the last elevations have taken place upon a soil already elevated upon a vault of the earth, and that in the same way the subsidence has happened on parts already subsided. It is yet possible that a chain may be wholly upheaven in later times; but our Alps in Europe shew us that we can hardly admit of a single elevation of 8000 feet at once, for all the summits and pinnacles which reach above 10,000 feet did gain this height only by the inclination of their composing beds. On the other hand, a yet unknown physical law has established an intimate relation between the value of the greatest elevations or upheavings, or highest mountains of each continent and their relative individual extent. A kind of scale of this description is furnished by the Himalaya, the Chimborazo, and Mont Blanc, three continents of unequal greatness.

The same relation is to be observed among the cavities of the earth, for the greatest sea depths are in the Austral seas, where the extent of dry land is to that of water as 1 : 16.

The same may be said of the southern part of the Pacific, which is as large as all the continents together. On the contrary, in the Northern Ocean to the 30th lat. north, the sea has only a relative smaller depth, and the dry land fills up there nearly as much space as the water.

We may observe, probably, that the volcanic action may modify our conclusions. We find, for instance, in Mont Blanc only metamorphic rocks, and in the Himalaya, secondary slates, and the highest pinnacles of the Andes nothing else than volcanic cones, so that we can only compare the height of the old vaults upon which these volcanic matters were united.

Volcanic action is still an agent very little known, and its force of elevation has not yet been determined. When we see on certain large volcanic islands, heights like those of Mont Blanc, for instance in Sicily, at Teneriffe, &c., and even still higher peaks in other volcanoes, those immense accumulations of igneous matters do not decide the question, if the volcanic force has been able to elevate a Chimborazo at the height of 24,000 feet from the mentioned normal sea-depth of 1500 to 2000 feet. According to all our observations, it must, on the contrary, be admitted, that the volcanic islands give us the limits of the volcanic force of elevation, and that in other places the height of the base of the volcanoes enables us to judge of their extraordinary altitude. In that way we see the lava flowing constantly from the crater of the Kirauea volcano upon the isle of Hawaii, which is only 3800 feet in height. We see volcanoes like Etna ejecting periodically stones to a height of 6000 feet, but the lava flows only through rents in the sides of the cones far below the high summits. In the Andes, whose trachytic domes predominate, the eruptions are also below, and the ashes and smoke go out above. This position of the volcanoes of South America upon the earth's vaults, may possibly explain how the volcanic phenomena and earthquakes in those countries are much stronger than elsewhere, because the action takes place under a covering filled with more rents, and more easy to be moved, being already bent to a vault. Generally, the higher the volcano, it is the more easily moved; on the contrary, the lower, even when submarine, the motions are, the more difficult, and its effects more local. For in this resides probably partly the difference between the present and the former activity of volcanoes. These have lost very little or nothing of their former exciting cause, but only the secondary circumstances of their possible expansion by this force have been modified by time.

Let us continue our approximative estimation of the *Heights of Chains* in the primitive periods, according to the mentioned depths of the various seas at different times; the highest hills in the Primary period would be between 1500 to 2000 feet, in the Zechstein period already 3000 to 4000 feet, in the Trias time 4000 to 5000 feet, in the Jura period 5000 to 6000 feet, in the Chalk time 6000 to 11,000 feet, in the Tertiary period 8000 to 20,000 feet, and in the Actual, 10,000 to 26,000 feet. The middle value of these highest pinnacles would be for the period of the Trias and Jura about 4000 feet, in the Chalk period 8000 feet, in the Tertiary period 10,000 feet, and now it would be 12,000 feet.

The *mountains next in height* would have increased in extent from the oldest times till now, as well as the inclined planes under the sea level. The greatest height of those chains may have attained in the Trias already 3000 feet, in the Jurassic period about 4000 to 5000 feet, in the Chalk period 6000 to 8000 feet, in the Tertiary time about 4000 to 10,000 feet, and now they measured 6000 to 12,000 feet. Their middle value would give only 2000 feet in height for the Trias period, 3000 for the Jurassic, 7000 for the Chalk, and 8000 for the Tertiary one.

The greatest *height of the hilly countries* may have been in the Primary period 1000 feet, in the Zechstein 1500 feet, in the Trias 1600 to 1800 feet, in the Jurassic 2000 feet, in the Chalk 2500 feet, and in the Tertiary at least 3000 feet. Their *middle height* which varies now between 1500 and 3000 would have attained in the primary times only 600 feet, in the Zechstein period 1000 feet, in the Trias 1500, in the Jurassic 1000 feet, in the Chalk 2000 feet, in the Tertiary time 2500 feet, and in the Alluvial 3000 feet.

On the Middle Height of the lowest parts of the Continents, according to Humboldt and Johnston.

We can limit the estimations for each continent and can draw the conclusion how small that height must have been in the Primitive period. In Europe the middle height gives now only the middle value of 300 feet. As the middle value of the highest chains of the mountains of middle heights of the hilly land in the Alluvial period, is to that in the Primary time about 4 or 5 : 1 in the Zechstein, about 3 : 1 in the Trias, 2 : 1 in the Jura, as 2, 2 : 3 in the Chalk, as 2, 3 : 3, and in the Tertiary as 2, 5 : 3, we obtain by using these researches in the middle height of the lowest parts of the continents in the different Primary periods 60 to 80 feet, in the Zechstein period 100 feet, in the Trias 150 feet, in the Jura 180 feet, in the Chalk about 200 feet, and in the Tertiary 250 feet. These values are naturally contrary to those of the cavities of the parts of the sea bottoms which were the nearest to the shores during the different geological periods.

With the aid of such philosophical collections of heights as Strantz gave us, (*Berghaus' Annal.*, 1830, vol. ii.; 1832, vol. vi.; 1835, vol. vii.; 1836, vol. xiii.; 1839, vol. xix.; 1841, vol. xxiii.), one might with some difficulty establish by approximations similar values for the breadth of the chains, the height of the plateaux and cols, the breadth of valleys, the length of the course of rivers, &c., during the different geological periods. I may only mention one of these, viz., the angle of inclination of the low lands and of the lands of the middle heights for which Strantz adopts for the first 5° to 10°, and the latter 10° to 20°. These values have increased always from the older times till now, a fact which shews the necessity to admit in the Primary times not only a much flatter land than now, but quite flat shores. Quite the contrary must have taken place in the chains, because the higher were not protected as now by so many mountains of secondary height; so that the angle of inclination of these last is much smaller than formerly. Generally this value rises with the smallness of the hill and diminishes with its greatness. But this value of the inclination of the plane must have diminished in the hills from the beginning till now, a fact which, on the other hand, conducts us to acknowledge that the current of water, their destructions and alluvium, must have been much greater the more we look back to these primitive times. Probably about the chalk period the beds of rivers may have become long enough to equalize the results of the greater angle of inclination with those of the shorter beds of these.

Let us try, lastly, to determine geognostically the *chief places of the continents in the various geological periods*, in going back from the present time to the oldest.

As the subsidences increase always in a certain arithmetical progression to the newer, and the elevations follow the same scale, it is clear that the present world must have possessed much more dry land at the beginning of things.

In the *alluvial time* great countries have disappeared to the NNW. and west of Europe; this we may suspect by the position of the greater parts of the low land,—by the chief subsidences in Europe and Africa,—by the destruction of part of the Tertiary beds and basins,—by many islands and many shallows of certain seas, as between Norway and Spitzbergen, in the German Sea, in the Gulf of Bevin, &c. But according to our observations they may have existed already in the old alluvial time (*Proceed. Vienna Acad.*, January 1852). The myth of the lost Atlantis may well be a true tradition.

In North and South America similar relations indicate for the same period of time subsidences in the north-east direction for North America, and in south-east and south-west for South America. In the mean time was found in the Pacific, the great equatorial cavity in Southern Asia, especially that amongst the Indian Archipelago and east of Africa,—a subsidence in the south-east direction.

In the *tertiary period* numerous basins indicate many great seas which did cover the lowest parts of the earth's surface, as I have detailed it already in the *Proceedings of the Vienna Acad.* for 1850, pp. 96–102; and also less completely elsewhere. As these parts form the largest portions of the earth's surface, this relation alone convinces us that much dry land disappeared in later date under the sea. In the same geognostical way I have shewn the place that the sea has occupied in older periods. During the Alluvial time a good deal of land formed by Tertiary beds, Chalk, Jura beds, and even by Primary fossiliferous and crystalline rocks, subsided in the Atlantic, and in the Pacific the countries that disappeared may have belonged to the tertiary, primary, and crystalline rocks. To the south-east of Africa, fragments of land have subsided, belonging to all the four classes of formations.

In the *middle and older secondary periods*, it would seem that the countries lying on equatorial lines in the Pacific did replace the Australian countries, which had again subsided, as well as part of the dry land of both peninsulas in Hindustan. The secondary formations do not appear in these latter countries, because they could not be formed there. According to similar considerations, it may appear probable that a part at least of Eastern America and a part of Western Africa were again put under water by subsidences. It is possible that the rent of the Red Sea took its origin in that time, for it is surrounded by much chalk and tertiary rocks. Later, at the end of the Jura time, on the contrary, these countries must have been thrown up, and the motion must have lasted till the Alluvial time. This we prove by the chalk mountains, and the now dry tertiary basins.

In the Primary period were islands in all seas, especially distributed in an equatorial direction, because this position coincides most with the density of the centrifugal force, which had not then attained its present limits in the process of rotation.

Before we conclude, we may observe that later observations will certainly complete this essay. Through the progress of palæontology, and natural history, zoologists and botanists have been able not only to restore and delineate to us the old fauna and flora, but they have also deciphered the philosophical plan of the origin and development of organic nature. In the same way, geology and physical geography will illustrate the once palæohydrography and orography, and follow nearly all the changes in the palæoplastics of the earth. We shall obtain then, as complement of our actual geological maps, others for each period of time; and in the last will be indicated not only the place of the various formations, but also the values of the various elevations and subsidences. These values will consist in the indications of the height, extent, and breadth, of the chains, of the angle of inclination of those as well as of the beds of rivers, the depth of the seas, the temperature of the different periods, the magnetic phenomena during these periods, and, last, the general geography of the different fossil flora and fauna.

A beginning is made in this way with the *Palæohydrography* and *Orography*, but the palæophysics are hardly studied, and even less the palæochemistry. We have got very few notions on palæometeorology and palæotemperature or thermics, as for instance in the changes in the isothermal lines in the geological times (*Bul. Soc. Geol.*, 1848, vol. v. p. 276). The palæomagnetism, connected intimately with temperature changes, will also give rise to most interesting discoveries, and even to magnetical maps in the various geological periods. Upon palæohydrology, I may soon treat, and upon palæopotanography I have selected a few facts already (*Mem. of the Vienna Acad.*, 1851, vol. iii. p. 89). In a later paper I have shewn, by the various degrees of heat in the thermal waters, where many different vegetables and animals of higher and lower classes may have lived, and that the temperature of the sea, at the beginning, could not have been so great as philosophers thought. The maximum of that temperature could have varied only between 70° and 80° C.; but in the general one I found only about 30° or 40°, like Sir H. de la Beche (*Bul. Soc. Geol.* for 1852, vol. ix.) The last knowledge mankind will acquire is that of *Palæoastronomy*; but a proper knowledge of this branch will require many centuries of time.

On the recent Progress of Ethnology. By RICHARD CULL, Esq., Honorary Secretary to the Ethnological Society, and Corresponding Member of the Historical Institute of France.*

Two works by Dr Latham, one of our fellows, have been published during the year—"*The Ethnology of Europe,*" and "*The Ethnology of the British Isles.*" These are valuable additions to our literature, and bear the characteristics of Dr Latham's vigorous mind. Much of the matter is necessarily familiar to us as admitted science; and not a little containing his own views has already appeared in his former publications. Dr Latham is doing good service to our science by casting doubt and uncertainty on much of that which is believed to be true, but of which the evidence is unsatisfactory. Thus, in a former work, he drew attention to the limited data on which Blumenbach erected and eulogized his Caucasian race; he now draws attention to the Saxons, and displays with ability his view of the place which they occupy in English history. And this view is not very flattering to the vanity of those who boast of Anglo-Saxon origin.

One of the great questions of European Ethnology, the origin of the Etruscans, has been again discussed during the past year. This subject has occupied the attention of some of the profoundest scholars of our times, but unfortunately with results much disproportioned to the labour which has been expended. It is a question that only scholars can discuss, for the investigation is historical, philological, and critical, on materials collected both in ancient and modern days. Dr Donaldson has, with praiseworthy industry, in Varronianus, second edition, along with treatises on the Dialects of ancient Italy, given in fuller detail than in his paper read before the British Association, the evidences and data of his views on the language and consequent origin of the Etruscans.

The population of ancient Italy, as Dr Prichard (*Physical Hist.*, vol. iii., p. 203), has shewn, may be conveniently thrown into three great groups, viz.:—

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* From a copy communicated by the Author.

1. The Umbrians, who may be deemed to be the earliest known inhabitants of North Italy, *i. e.*, of nearly all Italy lying between the Alps and the Tiber.

2. The Etruscans, who at a remote period dispossessed the Umbrians of a great part of their territory: they called themselves Rhaséna.

3. The population of Italy south of the Tiber consisted of several nations, termed Siculi, Œnotrians, Aborigines, Latins, Sabines, Opici or Ausones.

Dr Donaldson's view is, that the Etruscan language is in part a Pelasgian idiom, more or less corrupted by contact with the Umbrian, and in part a relic of the oldest Low German or Scandinavian.

Scholars in general deem the Etruscan to be a composite language. Dr Lepsius adduced evidence to support his view that the Etruscans were Tyrrhenians or Pelasgians, who invaded Italy from the north-east, conquered the Umbrians, and took possession of the western part of the district formerly occupied by that people. Dr Donaldson claims to have discovered a Scandinavian element in the Etruscan language. The evidence, however, which is adduced in support of the existence of such an element is considered by high philological authorities to be as yet unsatisfactory; and it appears that our knowledge of the Etruscan language is nearly where Niebuhr left it, viz. that *aifil ril* means *vixit annos.*

Professor Newman in his *Regal Rome, an Introduction to Roman History*, has ably stated the leading characters of the Ethnography of ancient Italy. Professor Newman shewed years ago, *Classical Museum*, vol. vi., that even Cicero's Latin abounds with intrusive Keltic elements; and especially that the Sabine was related to the Gaelic. He considers (" *Regal Rome,*" p. 18), that the primitive Latin must have derived its Keltic infusion through the Umbrian. Müller, as quoted by Prichard, observes, that words belonging to the barbaric portion of the Latin language abound in the Eugubian tables, which are Umbrian. Yet he admits that the dialect of these tables displays considerable analogies with the Greek. And Grotefend had long ago shewn that the Umbrian and Latin have an extensive vocabulary in common, and that they abound in analogous grammatical forms both in verbs and nouns. Here are difficulties for criticism to reconcile. But whatever was the medium through which the Keltic element was introduced into the Latin language, we shall agree with the Professor that the Keltic is the intrusive element, because, in numerous instances, the word which is common to the two languages is isolated in the Latin, while in the Keltic it is one of a family. The question may still be asked, Who are the Umbrians? It is true that the Umbrian language is cognate with the Latin, but its precise affinity has yet to be shewn. Dr Latham (*Varieties of Man*, p. 554), because Livy says the languages of Etruria and Rhætia are alike, thinks the Etruscans and Rhætians are one people; the former at their highest refinement, the latter at their greatest rudeness: and also considers the stock to be indigenous to Northern Italy. It appears to me that we lack evidence, and, unfortunately for their reputation, scholars are drawing wider conclusions than are warranted by the facts.

An able paper on the Romanic languages of the Grisons and Tyrol was read last session by Dr W. Freund, one of our Fellows, in consequence of which the Berlin Royal Academy of Sciences has given him the charge of a commission to proceed, at the Government expense, to ancient Rhætia, to make philological and archæological researches, so as to throw a light, by the collection of new facts, upon the ancient inhabitants of Etruria, the Grisons, the Tyrol, and the south-east of Upper Italy.

The next contribution to European Ethnology during the year is an account of the ancient inhabitants of Yorkshire, in Mr Phillip's excellent work *On the Rivers, Mountains, and Seacoast of Yorkshire.* Mr Phillips reproduces Yorkshire in the time of the Romans, and shews its successive phases under the Anglo-Saxons and Danes. His synopsis of its history during that long period is concise and clear. In an able chapter on the *Races of Men in Yorkshire*, Mr Phillips says,—“If, without regard to any real or supposed evidence of their national origin, we attempt to class the actual population of Yorkshire into natural groups, we shall find, independent of Irish immigrants, three main types frequently distinct, but as often confused by interchange of elementary features.

"1. Tall, large-boned muscular persons; visage long, angular; complexion fair, or florid; eyes blue or gray; hair light brown, or reddish. Such persons in all parts of the country form a considerable part of the population. In the North Riding, from the eastern coast to the western mountains, they are plentiful. Blue-eyed families prevail very much about Lincoln.

"2. Person robust; visage oval, full, and rounded; nose often slightly aquiline; complexion somewhat embrowned, florid; eyes brown, or gray; hair brown, or reddish. In the West Riding, especially in the elevated districts, very powerful men have these characters.

"3. Persons of lower stature and smaller proportions; visage short, rounded; complexion embrowned; eyes very dark, elongated; hair very dark. (Such eyes and hair are commonly called black). Individuals having these characters occur in the lower grounds of Yorkshire, as in the valley of the Aire below Leeds, in the vale of the Derwent, and the level regions south of York. They are still more frequent in Nottinghamshire and Leicestershire, and may be said to abound amidst the true Anglians of Norfolk and Suffolk. The physical characters here traced cannot be, as Dr Prichard conjectures in a parallel case in Germany, the effect of some centuries of residence in towns, for they are spread like an epidemic among the rural and secluded population as much as among the dwellers in towns. Unless we suppose such varieties of appearance to spring up among the blue-eyed races, we must regard them as a legacy from the Roman colonists and the older Britons, among whom, as already stated, the Iberian element was conjecturally admitted.

"Adopting this latter view, there is no difficulty in regard to the other groups. They are of North German and Scandinavian origin, and the men of Yorkshire inherit the physical organization and retain many of the peculiarities of language of their adventurous sires. In the words employed, in the vowel sounds, the elisions, and the construction of sentences, the Yorkshire dialects offer interesting analogies to the old English of Shakspeare and Chaucer, the Anglo-Saxon of the Chronicle, and the Norse, as it is preserved to us by the Icelanders."

Professor Phillips furnishes us with philological materials for the study of the East Yorkshire dialect, and says,—"Investigations of this kind (philological) must not be limited to Yorkshire, for even our dialectic peculiarities spread southward into Derbyshire, westward into Cumberland, and northward to the foot of the Grampians. Though several dialects, or varieties of dialects, exist in Yorkshire, they appear not so different from each other when heard, as when looked at in the disguise of arbitrary spelling." This work of Professor Phillips must be regarded as a valuable contribution to the Ethnology of England; and it is to be hoped that others as well qualified will supply us with the ethnological details of their own localities.

Our science is indebted to John Grattan, Esq., of Belfast, for obtaining certain ancient Irish crania from the round towers and other places, for carefully preserving them and bringing them under the notice of the Ethnologists at the Belfast meeting of the British Association last year. It is not easy to overrate the importance to our science of the study of crania, both ancient and modern. Mr Grattan ably classed his crania in four well-defined chronological groups, viz. :—

1. The Prehistoric,
2. The remote historic,
3. The Anglo-Irish, and
4. The Modern periods.

Mr Grattan modestly said,—"To attempt to generalize upon such imperfect data would be rash and presumptuous in the extreme. Let us hope, however, that, by calling public attention to the value of such specimens, we may be but laying the foundation of a collection, which, one day more extended and in better qualified hands, shall do good service to science. They however illustrate *one fact*, which bears importantly upon the question of races, viz. the tenacity with which different types preserve their identity even through periods of time which embrace no small portion of the history of mankind." It is with great pleasure I inform you that some of these crania will be figured and described in the large work on Ancient British Crania which my friend Dr Thurnam is now preparing for publication.

Africa.—The recent progress of African discovery so amply repays the labour bestowed on it, as to satisfy the desires of the most ardent. Some account, in an agreeable though desultory form, of the scientific labours of the Prussian mission to Egypt and Nubia, under Dr Richard Lepsius, has appeared in an English dress, under the title "*Discoveries in Egypt, Nubia, and the Peninsula of Sinai, in the years* 1842–45, *during the mission sent out by His Majesty Frederick William IV. of Prussia.* By Dr Richard Lepsius."

These letters, on their arrival in Europe, appeared in various journals, chiefly in the *Preussiche Staatzeitung*, and thence were copied by other papers. The collected letters, therefore, although only now published, are not new to us; and some of the lingual questions connected with Ethnology were discussed in our society as long as six years ago. The letters are edited by K. R. H. Mackenzie, Esq., who appears to be well acquainted with the Ethnology of North-East Africa.

Much valuable information concerning the tribes in the interior of Africa around Lake Tsad has been collected by the enterprising travellers, Drs Barth, Overweg, and Mr Richardson, which is at present in the Foreign Office, but which the Foreign Secretary has kindly promised to lay before our Society.

Dr Daniell, a Fellow of our Society, and distinguished by his Ethnological researches in Africa, safely arrived at Macartney's Island, on the Gambia, in November last. He informs me that he is now in the midst of an unwrought ethnological field, and which he hopes to turn to good account. I trust his life will be preserved to pursue those researches for which he is so well qualified, and that he will return to us in robust health to enjoy the *otium cum dignitate* after his long and laborious sojourn in the pestilent marshes of the west coast of Africa.

The publication of a second edition of the Rev. Samuel Crowther's Yoruba Vocabulary, now greatly extended, and also a grammar of the language by the same, a native author, supplies us with ample materials for the study of that beautiful language: while the able introduction by the Bishop of Sierra Leone is a valuable contribution to African philology.

A characteristic of African languages is the euphonic concord, which was first discovered by the Rev. W. Boyce, of the Wesleyan Missionary Society, and published in his grammar of the Kaffir language; but its principles have been since more fully laid down by the Rev. John W. Appleyard, in his more elaborate grammar of that language, in which its extension to other South-African languages is exhibited.

The Yoruba language, which is not a South-African one, has its euphonic concords, and that between the verb and the pronoun is worthy of attention. The pronouns are, 1*st*, "emi;" 2*d*, "iwo;" 3*d*, "on," in the nominative case; but these nominatives have each two other forms, which depend on the vowel of the verb. And the third personal pronoun has seven forms dependent on the verb's vowel, when used in the objective case. In this way the pronoun is always subordinated to the verb. Now, although the existence of euphonic concord connects as one link the Yoruba with other African and chiefly South-African languages, yet at present I confess I do not see the special links which will enable one to say to what group it naturally belongs. At present, however, we know but little of African philology. I need scarcely say in this society that euphonic concords are not confined to African languages, as every one knows they are found in the Keltic.

The Rev. Dr Koelle of the Church Missionary Society, has lately returned from Sierre Leone with MS. vocabularies of 150 languages, and with MS. grammars in an advanced state of compilation of the Bornon, and the Vei, the former of which, he informs me, has some features in common with the Ugro-Tartarian languages and some with the Semetic, the existence of which will modify our views of the Negro languages. He is now engaged in preparing this valuable contribution to our knowledge of African languages for the press. Dr Koelle informs me that his vocabularies do not extend to those languages spoken in the north-east of Africa.

The continued lingual researches of Dr Krapf in the dialects of the east and north-east of Africa; those of Mr Appleyard in the south of Africa from east to west, with the researches into the Negro languages of the western coast, seem to render the lines of demarcation between them less trenchant, and to indicate certain affinities which may confirm the conjecture of Dr Prichard of a close connection between all the African languages. Much, however, remains to be done in collecting vocabularies, shewing the areas in which the languages to which they belong are spoken, and the compilation of grammars. We must not remain satisfied with the indications of affinities; we ought from positive knowledge to exhibit the whole of their several relationships. And we must never forget that lingual evidence, however strong and perfect, is only one line of evidence: we must obtain the concurrent testimony of the other lines of Ethnological evidence in order to justify our conclusions.

"Kaffraria, and its Inhabitants," by the Rev. Francis Fleming, M.A., Chaplain to the Forces in King William's Town, is a small volume, containing a popular but animated description of the country, and so much of its natural history as the author found necessary to introduce an account of its human inhabitants. Mr Fleming's knowledge is gained from a personal experience of three years' residence. The large space devoted to a description of the native tribes and their languages, displays the author's ideas of the importance of Ethnological knowledge; and the little work is likely to be useful in exciting a desire for more extended and systematic knowledge of the South African.

Asia.—Steady progress continues to be made in deciphering the cuneiform inscriptions of Assyria. These inscriptions are the original public records of the empire, and are of infinitely higher value than ordinary ancient MSS., because, being the originals, they are free from those corruptions which creep into all MS. copied texts, either from the inadvertence or the wilfulness of the transcribers. The great question is, Can we correctly read them? Some persons, who are unacquainted with the philological methods of research adopted in this inquiry, or whose philological knowledge is insufficient to enable them to appreciate those methods, have called in question the results of the labours of our distinguished investigators. But I believe that all who have studied those methods are satisfied that we possess the philological key to open the immense and invaluable stores of knowledge which are locked up in those languages. Mr Layard's new book, just out, is the last work on ancient Assyria. In it is a translation from these cuneiform inscriptions abridged, the joint production of Mr Layard and Dr Hincks, of the annals of King Sennacherib, by which he is identified with the Sennacherib of Scripture (p. 159).

Colonel Rawlinson wrote a paper last year, containing an outline of Assyrian history, compiled from the inscriptions of Nineveh; and also a sketch of the Assyrian Pantheon, derived from the same source. To us, as Ethnologists, the important light thrown upon ancient geography, and the connection of the people with their several localities, is of equal interest to any of the Assyrian discoveries. The chronology is of great value; and these, together with the synchronisms of Biblical history, are already clearing away some of the Ethnographical darkness which yet enshrouds that interesting part of Asia.

Dr Hincks read a paper at the Belfast Meeting, in September last, of the British Association, "On the Ethnological bearing of the recent discoveries in connection with the Assyrian Inscriptions," which claims our attention. He considers the Assyrian language to belong to a family akin to that of the Syro-Arabian languages hitherto known, rather than to that family itself. Dr Hincks pointed out the following resemblances, or what the Assyrian had in common with the Syro-Arabian family.

It has verbal roots, which were normally triliteral, but of which some letters might be mutable or evanescent, whence arise different classes of irregular verbs. These roots admit not only the simple conjugation, but others in which radical letters are doubled, other letters added, or both these modifications made at once. From these roots verbal nouns are formed, either by a simple change of the vowels, or by the addition of letters, such as are called, in Hebrew, Heemantic.

The Assyrian agrees with the Arabic more closely than with any other of the Syro-Arabian family in these respects :

1*st*, In forming the conjugations, consonants are inserted among the radical letters, as well as prefixed to them. This takes place regularly in Arabic, but in Hebrew only when the first radical is a sibilant.

2*d*, The termination of the aorist varies as in Arabic, different verbs taking different vowels between the second and third radicals, while the first radical sometimes terminates the verbs, and sometimes takes after it *a* or *u;* and,

3*d*, The forms of the plural vary, and the cases of nouns differ in a manner which resembles, in some measure, what takes place in Arabic.

The Assyrian language differs from all the Syro-Arabian languages yet known in the following respects :—

1*st*, Where they have *h* it has *s* in a variety of instances, and especially in the pronouns and prenominal affixes of the third person—*Su, si, sunu, sina ; sa, sa, si, sun*, and *sin*—most of which resemble forms in other languages, if only *h* be substituted for *s*. The same difference occurs in the characteristic of the causative conjugation. In these respects, but not by any means generally, the Assyrian agrees with the Egyptian, and, through it, with the modern Berber.

2*d*, The Assyrian has no prefixes, such as *b* for *in*, *l* for *to*, which occur in all the Syro-Arabian languages. In place of these it has separate prepositions: and to evoid the awkwardness of joining these to the prenominal affixes, and perhaps for greater clearness, nouns are inserted, forming compound prepositions, as *ina kirbisu*, "in its midst," for "in it." Compound prepositions may be used, also, before other nouns, as *ina kirib biti*. Sometimes the Assyrian uses affixes as substitutes for prepositions. Instead of *ana*, "to" or "for," before a noun, *ish* may be added. Thus, for "a spoil" is expressed indifferently by *ana shallati* and *shallatish.* This last form has much of the nature of an adverb, and has some resemblance to the Hebrew noun with the locative. In place of *ish*, the pronoun, generally *ma*, is adopted as a substitute for *ana*. Thus *su-ma* is "to him," and answers to *le-ho*, from which *lo* is contracted; the Hebrew prefixing the representative of "to," while the Assyrian postfixes it.

3*d*, The Syro-Arabian languages make frequent use of a preterite, in which the distinctions of number and person are confined to the end of the root; but the Assyrian rejects it, or at least uses it in an exceedingly sparing manner. On this account Dr Hincks proposes to consider the Benoni participle, masculine, singular, *in regimen* as the root.

4*th*, The varieties in the termination of the future are not connected with any particles that may precede them, but of themselves indicate different tenses. The termination in *u* is certainly a pluperfect. Thus, where mention is made of "that Marduk Baladan, whom I *had defeated* in my former campaign," the verb is *askunu:* but whenever "I defeated" occurs in the simple narrative, *askun* or *askana*, or, in a different conjugation, *astakan* is used. This law has been fully established. The addition of *a* seems not to change the sense; it is added to every verb when what it governs follows it, and to some verbs even where it precedes it. These are chiefly such as denote locomotion.

The resemblance of the most common Assyrian prepositions, and that of the pronouns, also, to the Indo-European form is curious, and points to a common though remote origin.

The Babylonian inscriptions are in the same language as the Assyrian. This was probably the court language at Babylon; but the common people most probably used the Chaldean language, in which some parts of the Books of Ezra and Daniel are written.

Mr Hodgson is still contributing towards our knowledge of the monosyllabic languages in Trans-Gangetic India, and the results of his inquiries are recorded in the *Transactions of the Bengal Asiatic Society*. The present war in Burmah will, I trust, open up that and the surrounding countries for

Ethnological inquiry; and should the dynastic struggle which is now going on in China be finally settled by British arms or diplomacy, we may hope for the opportunity of studying more perfectly the Ethnology of that vast empire. Trans-Gangetic India and the Chinese empire may be considered as one extensive Ethnological area, the languages of which are monosyllabic and the religion Buddhism.

Mr Oldham, Geologist to the Indian Survey, has been studying the hill-tribes north of Sylhet; and a valuable communication was read to our Society on the subject on the first night of the session. We may expect further knowledge of these various tribes from him, as he has gone to that locality a second time with specific objects of inquiry. He says: "I am satisfied the language is monosyllabic: and I think the Garo tribe is more nearly allied to the Kassias, Kukis, Kachari, and Munipari, than with the Bodo or Dhimal." He is now studying the mutual relationship of these hill-tribes.

Mr Logan, another of our Fellows, continues his scientific researches in the Indian Archipelago. He and his band of contributors record the result of their investigations in the Journal of the Indian Archipelago and Eastern Asia. Residing in that distant part of the world, they devote their energies to the study of its nature. Mr Logan's contributions to its Ethnology are of the highest character. His papers on the languages of the Indo-Pacific islands place him in the foremest rank of ethnological philologists, and give us more precise ideas of the migrations which led to populating those islands.

Mr Logan is animated by an intense desire of knowledge, with an untiring zeal in its pursuit, and aims at the high object of exhausting his subject. In a letter which I lately received from him, speaking of the Polynesian languages, he says: "I think you will find that I have pretty well exhausted our present linguistic data in my forthcoming chapters, and thrown new light on the Polynesians, but we require more facts for Micronesia and Papuanesia, before we can go further. In my next chapters I take each geographical group separately (*e.g.* Sumatra and its islets, Java and its islets, Borneo and its islets, and so on to Polynesia)." . . . .

"Within the last six weeks (January 6, 1853) I have received vocabularies of several new Borneon and Moluccan languages."

I am anxiously waiting for the continuation of Mr Logan's chapters on these languages, for he has already thrown a flood of light on the Ethnology of the Malays and the Polynesians.

A valuable contribution to our knowledge of Buddhism in Burmah is made by the Rev. P. Bigandet, in a translation from a Burmese MS. of a legend of the Burmese Buddha, called "Gaudama." The MS. was brought from Ava, which is a great seat of Buddhist learning. The original text was in the Pali, from which it had been translated into the Burmese language.

Another contribution to our knowledge of Buddhism, as it exists in Camboja, entitled, "Notice of the Religion of the Cambojans," taken from a MS. of M. Miche, Bishop of Dansara, also appears in vol. vi. of Mr Logan's Journal. "Whoever has sojourned in Camboja will have remarked certain points of doctrine difficult to reconcile to each other, and even with those mentioned in this notice. There is nothing wonderful in this. Some are taught in books, others are the popular beliefs. Moreover, it is not unusual to hear the Cambojans say amongst themselves, Such a pagoda does not teach the same as a neighbouring one: their books do not even always agree." Knowing the extensive area over which Buddhism prevails, we might expect it to vary both in doctrine and practice; but it must be confessed, that until this article appeared we had no notion that neighbouring pagodas varied in their teaching,

"A Manual of Buddhism, by the Rev. R. Spence Hardy." This is a valuable contribution to the literature of our science, as it ably answers the question, "What is Buddhism?" The manual is not a work written by the author after the mere consultation of Singhalese writings on the subject, but is itself an actual translation from Singhalese MSS. So that the work is not a view of Buddhism by a Christian, but by a Buddhist, and is, therefore, one of authority. The study of this work, in connection with the "Eastern Monachism" of the same author, published about three years ago, which describes the discipline, rites, and present circumstances of the Buddhist priesthood, will give us a complete idea of the nature and practice of Buddhism.

The Buddhist religion is that of many millions of people spread over a vast area, the whole of which, however, is in Asia. The Buddhist religion of China differs somewhat from that of India. "The sacred books of Burmah, Siam, and Ceylon, are identically the same. The ancient literature of the Buddhists, in all the regions where this system is professed, appears to have had its origin in one common source; but in the observances of the present day there is less uniformity; and many of the customs now followed, and of the doctrines now taught, would be regarded by the earlier professors as perilous innovations." (P. 357.)

The doctrines of Gotama, therefore, like those of every other founder of a creed, have been modified by his successors. Buddhism, and its powerful results, have been too little studied by philosophic historians. "There have been various opinions as to the age in which Gotama lived: but the era given by the Singhalese authors is now the most generally received. According to their chronology, he expired in the year that, according to our mode of reckoning, would be B.C. 543, in the eightieth year of his age." (P. 353.)

"Journal of a Cruise among the Islands of the Western Pacific, including the Feejees and others, inhabited by the Polynesian Negro races, in H.M. Ship 'Havannah,' by John Elphinstone Erskine, Capt. R.N." This valuable contribution to Ethnological Science is well illustrated by coloured lithographs of the natives. This contribution, however, as a whole, is not quite new to us, for the Rev. John Inglis accompanied Captain Erskine on a missionary tour to some of the islands, and gave us an account of it in a paper read in our Society, December 10, 1851: and made also a valuable contribution therein to the philology of the Papuan race.

Captain Erskine's Journal corroborates Mr Inglis' tour, and also adds to our knowledge of other islands in the Western Pacific.

We may expect further information concerning the Pacific islands from Captain Denham's expedition, which is now in that ocean

Mr Brierly, who accompanied the late Captain Owen Stanley in the "Rattlesnake" to New Guinea, the Louisade Archipelago, and the North-Western Pacific Islands, is engaged in preparing for publication the ethnological materials which he gathered in that cruise. His abilities as an observer, and the opportunities he enjoyed, have been turned to good account; and I am able to say that his forthcoming work will extend our knowledge of the Ethnology of that area.

America.—The study of the Ethnology of North America is being pursued with that energy and comprehensiveness of purpose which characterize that people. The Government of the United States appointed a commission of well-qualified men to study, record, and publish historical information concerning the Indians in its territory. A magnificent work in quarto is the result, of which the second volume reached Europe in the autumn. This work contains a description and history, with the manners, customs, and language, as exhibited in copious vocabularies and grammars, of the several tribes of Indians. The two volumes already published are well illustrated by copperplates and woodcuts. The comprehensive design of giving a systematic account of the people who are fast fading away before the advances of a higher civilization, is one that we might copy with great advantage to our national character both in British America and in our other colonies.

The Smithsonian Institution, in its systematic cultivation of natural knowledge, embraces that of Ethnology, and in its volumes are found most valuable contributions to the Archæology of the Indian tribes. The researches connected with the earth-works of the Mississippi Valley, by the Hon. E. G. Squier, who is a Fellow of our Society, in vol. i., and those connected with the earth-works in Ohio, in vol. iii., by Charles Whittlesey, Esq., are important contributions to the ancient Ethnology of those districts.

The American Ethnological Society is not idle, but, on the contrary, is contributing its quota to the elucidation of American Ethnology. The first part of vol. iii. is just issued from the press, and contains much new and interesting matter. The Hon. E. G. Squier, whose work on Nicaragua is an authority, is still studying and throwing a light on that district. A paper, "On the Archæology and Ethnology of Nicaragua," in the present Part, is a valuable contribution to our knowledge, both of the tribes and of their languages. Prior to Mr Squier's visit, our information of this interesting district was very meagre and sketchy. A knowledge of these tribes is likely to point out what relationship existed between the Mexicans and Peruvians, and also the relationship of both to the great American family of Man.

The British Association for the Advancement of Science has printed for circulation, in order to rightly direct inquiry, a new edition of its queries, under the title of "A Manual of Ethnological Inquiry." From the circumstance that the leading Ethnologists of Great Britain belong both to our Society and to the British Association, there is a unity of action in the two Societies, in the endeavour to collect the facts and data of our science. And my being Ethnological Secretary to Section E, as well as Honorary Secretary to our Society, the object of the Association in the distribution of its Manual can be more fully carried out. Copies have already been sent to nearly every missionary station in the world; and from the concise directions as to what to observe, we may expect a large mass of facts to be brought together for the advancement of Ethnology.—(*From Sketch on the Recent Progress of Ethnology. By Richard Cull, Esq.*)

On Cohesion of Fluids, Evaporation, and Steam-Boiler Explosions. By Lieut. E. B. Hunt, Corps of Engineers, U.S.A.* Communicated by the Author.

I now wish to present a simple exposition of the mechanical theory of cohesion in fluid masses, and from this to deduce the structure of a fluid surface, shewing that its cohesive strength is much less than that of the interior layers. The result furnishes a clear and direct explanation of the great fact of evaporation, and shews why, in all cases, even in ebullition, evaporation is a strictly surface phenomenon. Hence follows an explanation of one of the chief causes of steam-boiler explosions, and the easy suggestion of a very practical remedy; also an explanation of the heating of fluids to high temperatures, as observed by Donny, and of the entire agency of contained air in ebullition.

Several years have now elapsed since, in tracing out the results of a highly general theory of molecular mechanics, it occurred to me to call in question the commonly-received views as to the amount and character of a fluid cohesion. Regarding all cohesion as directly a function of the distance between adjacent molecules, it was quite impossible to imagine that the exceedingly small difference of the intermolecular distances corresponding to the fluid and solid forms respectively in any given substance, could produce that very great difference of cohesive strength so generally conceived to exist. The slight difference of volume, for instance, between a solid and fluid pound of iron, would not lead us to anticipate any marked difference of cohesion, so long as we regard this cohesion as any tolerably simple function of the intermolecular distances.

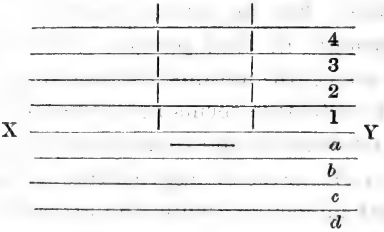
The ordinary experiments professing to measure fluid cohesion, are by no means cases of direct rupture, and indeed furnish no measure whatever of actual cohesive strength. The common experiment of separating, by counterpoising weights, a disc from a fluid which wets it, furnishes no indication of the cohesion in the mass of fluid, but merely shews

* Read before the American Association for the Advancement of Science, at Cleaveland, Aug. 1853.

the force required to break the fluid surface. Donny's experiments shew positively that the yielding is here entirely at the surface, progressing through the mass by the successive breaking of the successively formed surfaces, only a mere fluid filament being at last broken by direct rupture. It is truly a case of capillary action between a horizontal fluid surface and a horizontal solid circular surface, and like all other capillary action exists primarily at the surfaces only. Except in the frequently observed adhesion of well-boiled mercury in barometer tubes, to heights far above the true barometric level, we have in fact no record of any experiments exhibiting the resistance offered by a fluid mass to direct rupture, which only ought to be taken as a true measure of cohesion. All the common views of a slight fluid cohesion are based on erroneous interpretations, in which the effects of the easy mobility of parts in fluids are very loosely imputed to a low value of cohesion. Once clearly understanding that surface yielding gives no measure of cohesion or direct resistance in rupture, we can readily see that the prevalent ideas on this subject are without support.

If we study the phenomenon attending the condensation of gases and vapours into fluids, it is apparent that while contiguous molecules are still at distances many times as great as that characterizing the fluid state, the cohesive attraction manifests itself appreciably. Steam instantly condensing, at the rate of a foot of steam to an inch of water, shews that in water the cohesive action of a molecule extends effectively through a sphere whose diameter is at least twelve times the distance between adjacent molecular centres in the fluid. Hence in water the radius of effective cohesive action must be so great as to include several molecular layers. The moment a gas ceases to follow Mariotte's law, cohesive action becomes appreciable; and this is proof enough that in masses many layers contribute their action in making up the total cohesion.

If we conceive any fluid mass to be distributed into layers, then the correct measure of fluid cohesion will be the force requisite to produce a direct simultaneous separation of all the parts along a unit of the dividing surface between two layers. This is equal to the resultant of all the forces acting from either direction against this unit of surface, these forces being held *in equilibrio* by the equally opposing forces. To obtain an expression for this cohesion, let the fluid mass be conceived as divided into elementary layers relative to three perpendicular co-ordinate axes. Let the layers above the plane X, Y, be called 1, 2, 3, &c., those below being called *a, b, c,* &c. Take the unit of surface in the plane X, Y, between layers 1 and *a*. Then the force with which the unit in layer 1 presses against layer *a* is composed of all the attractions which the entire layers *a, b, c,* &c., exert on the



units in layers 1, 2, 3, &c., which make up the prism basing on the unit of surfaces. Or, making the cohesion ψ, and designating the elementary forces by the layers between which they are exerted, we have

$$\left.\begin{array}{r} \psi = a,1 + b,1 + c,1 + d,1 + \&c. \\ + a,2 + b,2 + c,2 + \&c. \\ + a,3 + b,3 + \&c. \\ + a,4 + \&c. \end{array}\right\}$$

in which the terms arranged above each other have equal values. This series would require to be extended so as to include all terms corresponding to distances at which cohesive forces may not be regarded as evanescent. By assuming some law of connection between this force and the distance, an integration of effect could be attained; but this is not now necessary. An inspection of the formula gives the main features in the mechanism of cohesion within masses, either solid or fluid.

In order now to study the peculiarities of constitution belonging to surfaces, let us, in this formula, introduce the hypothesis that layer 1 becomes a surface layer. All terms containing 2, 3, 4, &c., are thus struck out, and we have, as the surface cohesion along the normal direction, $\psi = a, 1 + b, 1 + c, 1 + d, 1 + \&c.$ But in the general expression we have, by observing the equality of terms,

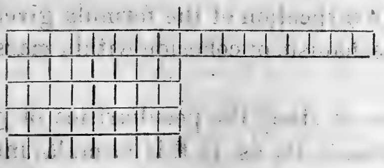
$$x = a, 1 + 2\,(b\,.\,1) + 3\,(c\,.\,1) + 4\,(d\,.\,1) + \&c.$$

Comparing these values of x, we see that the surface layer coheres to the mass with a very much smaller force than two internal layers cohere against each other. For the second, third, &c., layers, a like discussion applies, and the cohesion gradually increases on penetrating the mass.

This formula involves no particular hypothesis as to the value or character of the forces acting, only that the aggregate is attractive. But as condensation is a spontaneous phenomenon through all that portion of the aggregational range in which energetic actions are found, we ought to assume that all the effective terms are attractive. To present the grounds which seem to me to authorize the conception of that repulsion in all states of aggregation, is only exercised between adjacent molecules, while the attractive actions are the resultants of all the primary constitutional forces, and extend through larger spheres, would involve the exposition of a complete theory of molecular mechanics. I must, therefore, leave, as an assumption, the conception that in fluids the only repulsion to be taken into account is that between the contiguous layers (a and 1), which prevents their yielding farther to the cohesive forces pressing them together.

We should observe, that in consequence of the deficiency of cohesion along the fluid surface, a rarefaction would take place, which would again diminish surface cohesion to a considerable extent below that value given by the formula.

To determine the cohesion measured along a surface, as we have done for that along the normal, let the general formula be applied to a surface element. Then, instead of the



normal layers being full layers, they are essentially but half layers, or each term has approximately only one-half of its value for the interior. Hence the value of x is approximately only one-half of the interior value, or the cohesion along a surface is about one-half what it is within the mass. But as this value gives a rarefication also along the surface as well as along the normal, it will therefore be much diminished, so as to become less than one-half the general value. Thus both along the normal and along the surface, a weak cohesion is a necessary characteristic of the bounding layers of material masses, both fluid and solid. The result thus reached in respect to a mass *in vacuo*, would not be greatly affected in the ordinary atmosphere.

It is somewhat remarkable that Poisson's capillary theory, as stated by Mossotti, in Taylor's Scientific Memoirs, is based essentially on an analysis of the fluid surface, in which the halving of the normal layer is totally overlooked, and the cohesion along the surface is declared to be the same as in the mass, the surface layer only having been taken into account. I have not seen Poisson's work, but it is singular that Mossotti should either have made such an oversight, or have failed to detect it in Poisson, if he really committed it. It is a radical defect—even using Poisson's own hypothesis—and must directly affect, or even invalidate, his whole theory.

I come now to an important deduction from the preceding discussion. Fluid surfaces are in a state of weak cohesion as compared with fluid interiors; hence a partially atmospheric condition of rarefaction exists along such bounding surfaces. If, then, we assimilate heat to a molecular repulsion, as is customary, we see at once that as the temperature is raised the weak cohesion in the surface layer will be wholly overcome long before the mass is heated to that point which will overmaster its internal cohesion. Hence the surface molecules will freely pass off as vapour, while a strong cohesion still exists throughout the entire mass. Evaporation thus goes on at surfaces, at all temperatures above that which just suffices to overcome the weak surface cohesion. This constitution or structure necessarily characterizing the limiting layers of fluids, is the true and full explanation of evaporation in all its forms. From this we see that a fluid mass, without interior or exterior surfaces, or so inclosed as virtually to answer this description, might be heated up far above the boiling-point without boiling. We see that ebullition is but the effect of an internal evaporation starting in minute air-bubbles, and growing with the expanding bubble. We see that water entirely freed from air-bubbles, and with a restricted open surface, as in Donny's tube experiment, should go on heating up far above the boiling point, until at last the whole heated mass would flash into steam with an explosion. All the phenomena described by Donny, in his excellent paper in the *Annales de Chimie et de Physique*, follow as easy and obvious deductions from this constitution of the fluid surface. Indeed, we do not at all wonder his being forced, from his experiments, to conclude empirically that there must be some peculiar quality in surfaces, which makes evaporation take place so much more readily on them than in fluid masses. We see, too, how utterly fallacious are the experiments usually taken, as measuring fluid cohesion—they being in fact only results of the weak cohesion in surface layers—which, with the free mobility of fluid parts, fully explains all the observed results. This fully explains how a too perfect boiling of the mercury in barometer tubes makes it adhere at the top with such tenacity. It explains Berthollet's experiment on the forced dilatation of fluids, in which a deaërated fluid, sealed when hot, does not shrink in cooling for a long time, but at last breaks and collapses—indicating that it has borne a great tension before yielding. Prof. Henry's elegant experiments with soap-bubbles, in which by measuring the tension of the inclosed air, he is able to deduce, first, the compressing force, and thence the cohesion of the fluid film, with a very great value, furnish an independent confirmation of the same general views. We may remark that the heterogeneous structure of the outer layers would destroy the mobility of their parts, and give a film-like character to the fluid surface, while all within this film would have free mobility. This, with the additional fact of a drawing inward of the outer layers, by the unbalanced cohesive action of the layers near the surface, explains the great variety of formal phenomena exhibited by drops, bubbles, and fluid surfaces.

About four years since, I conceived the idea of directly measuring fluid cohesion by rupturing a pure fluid column in a cylinder with a moving piston. By filling the cylinder with the fluid to be tested, and immersing the piston by the aid of a valve closing at will, the force requisite for starting the piston will be the cohesion of the column, on allowing for atmospheric pressure. Of course, the fluid must adhere to the cylinder more strongly than it coheres in itself, else the adhesion only would be measured. Nor must it contain any air-bubbles, as the presence of one such, however small, will give a start to the break, by presenting a weak surface. This is the great difficulty of the proposed experiment. In May last, I had just begun such an experiment, on mercury, in an amalgamated cylinder, but the requisite precautions for excluding air could not be taken for lack of time, as I was obliged to leave my station before the apparatus was complete. The rapidity with which the mercury rushed past the piston, in the rough trials made, shewed that some packing will probably be requisite in a deliberate measurement, and this again will present the difficulty of introducing an unamalgamated surface in the mass to be broken. The precautions requisite for a perfect trial of the experiment are quite numerous. I anticipate that exceedingly small air-bubbles will have the effect of making the indications irregular, as the smallest bubbles will only start a break on the application of very considerable force.

I will now apply this discussion to steam-boiler explosions. The condition requisite for ebullition in boiling water is simply that air-bubbles in the heated portions shall present on their boundaries the weakly coherent surfaces requisite for evaporation to be established. Perfectly deaërated water, with a limited surface, would not boil at all, but would steadily heat up until it reached that point at which it would flash explosively into steam. Now, one chief cause of steam-boat explosions is clearly of this description. The boat stops at a wharf; "the doctor," or pump supplying water to the engine, being worked by the engine itself, stops its water supply when the engine stops. The water in the boiler goes on boiling until all the air-bubbles are boiled off from the water, and their air is mixed with the steam above. There then ceases to be any evaporating surface, except that on the top layer, which is farthest from the heating surface, and quite inadequate to the consumption of all the heat supplied. Then the mass of water begins to heat up, and it goes on storing up the unconsumed caloric, until the water is far hotter than the head of steam would indicate. The engineer then starts the engine; this starts the pump, which throws a stream of air-charged water directly into the glowing fluid. The heat instantly finds its outlet by an overwhelming evaporation on the newly supplied bubble surfaces, and a tumultuous ebullition follows. The gathered store of heat flashes off a portion of the water into steam of excessive tension—a tension such as nothing can withstand. The terrific consequences are too often witnessed in those fatal catastrophes which have given to our western rivers such a tragic reputation. No one can examine a list of western steam-boat explosions without being forcibly impressed with the frequency of these accidents just as the boat is starting from the wharf, after a landing. It seems to me beyond doubt that many of these occur just in the manner now stated, and from the deficiency of air-bubbles in the boiler. We see in this reasoning, too, a sufficient explanation of dry steam, or steam hotter than its tension indicates. The heating is then going on faster than the evaporation, and the steam is thus heated as if it were not in contact with the water, or were in a vessel by itself.

It is not always that the remedy for a danger is as obvious and as easily applied as in this case. It is only necessary to keep the pump in steady, slow operation, while the engine is at rest. It should always be capable of an independent movement, and should constantly, while a boat is fired up, be kept at work, however slowly. By this means air for ebullition will always be supplied, and the accumulation of heat in a sluggish mass of water cannot then go on until the explosion point is reached. The field over which I have thus rapidly traversed is one requiring much patient study for its full development and illustration. I could not here give all which belongs to it without exceeding reasonable limits. Nearly all the views which I have presented were the result of my own studies, so far as concerned my original acquaintance with them, but I was happy to find that Donny and Henry had, in some points, reached the same conclusions by independent routes. But I am not aware that any one has presented the same analysis of cohesio nor of the molecular constitution of material surfaces. Especially does the derivation of evaporation from molecular mechanics seem to me novel and worthy of careful consideration. Donny indicates essentially dëaeration as a cause of steam-boiler explosion; but it is as an experimental deduction, and not connected with its mechanical derivation.

In conclusion, I will present an outline of a most interesting illustration of creative design in the earth's co-ordination. The explanation of evaporation which has been given shews that for each fluid the formation of vapour lies within certain definite limits of temperature, as a result of primary structure. These limits differ greatly in different fluids. Now, in framing the earth for habitation, or for the proper life of animal and vegetable forms, something equivalent to rain was necessary, from the constant descent of fluids to the lowest level. Without some agency to lift the great organic fluid above its lowest ocean bed, sterility would have been the lot of all which rose above its surface, and terrestrial organisms would have been quite impossible. But fluidity does not involve evaporation except within certain definite limits, special for each liquid. Again, evaporation might freely go on, and yet no capacity for condensation exist, except within other limits of temperature, quite unattainable, save through special arrangement. Rain, then, with our earth and atmosphere, involved a special constitution of the raining fluid, not only so that evaporation at ordinary temperatures should go on, but so that condensation may again take place in the ordinary air. Not only must this qualitative arrangement exist, but also a quantitative one; since the quantity of rain best sufficing to the aggregate organic need is exactly a certain definite number of inches per annum.

Now, water is doubtless the only known liquid which could by possibility answer these definite mechanical conditions; hence we say, that there is a peculiarly clear evidence of design, first, in making a fluid which could, under our cosmical conditions, undergo the raining round, and secondly, in its being on the earth in so exactly the quantity best meeting the aggregate organic needs. Ether, quicksilver, or any other known fluid, could not, in any possible arrangement of quantity, supply this primary cosmical necessity. Now, when we reflect how many are the instances in which the terrestrial elements, simple and in combination, exist in strict adaptation to organic needs, both qualitatively and quantitatively, the cumulative evidence of design much exceeds that furnished by a locomotive or a cotton-mill. Not only is organic life framed in strict relation to the earth, but the earth is also primarily constituted in strict relation to organic life. Let whoever doubts this, study the extremely slender *a priori* chance that a drop of rain of any known liquid should ever fall upon the earth, and let him but picture the total lack of all land life which must have followed any cast of the die other than that really existing. Life without fluid circulation is totally inconceivable by the mind of man, and exactly to determine the appropriate kind and quantity of liquid, as has been done in the real frame of nature, was a problem of pure and absolute intellection, transcending the grasp of every mind save the all-wise creating Designer.

Researches in Embryology; a Note supplementary to Papers published in the Philosophical Transactions for 1838, 1839, *and* 1840, *shewing the Confirmation of the Principal Facts there recorded, and pointing out a Correspondence between certain Structures connected with the Mammiferous Ovum and other Ova.* By MARTIN BARRY, M.D., F.R.S. F.R.S.E.* (Communicated by the Author.)

The following are some of the principal facts recorded in my Papers on Embryology: others will be mentioned further on.

1. The spermatozoon penetrates into the interior of the ovum.

2. The germinal vesicle persists beyond the period at which it had been supposed to disappear.

3. Cleavage of the yelk, previously noticed in Batrachian Reptiles, and some Osseous Fishes, takes place in the ovum of the highest animals—Mammalia.

4. This cleavage of the yelk is effected by means of the nuclei of cells.

5. The nuclei effecting cleavage of the yelk have their origin in the germinal spot, which divides and subdivides to furnish them.

6. The nucleus of the cell neither "remains unaltered," nor "is absorbed as useless," after the formation of the cell-membrane; but continues to display properties which shew it to be the most important portion of the cell.

7. Ova of the Rabbit destined to be developed, are in most instances discharged from the ovary in the course of nine or ten hours *post coïtum*; and they are all discharged about the same time.

Two of these facts, viz., that regarding the period at which the ovum of the Rabbit is usually expelled from the ovary, and the fact that cleavage of the yelk takes place in the mam-

* The substance of a Paper read before the Royal Society of London, June 16, 1853.

miferous ovum,—both of which I published in March 1839,—received immediate confirmation. All the others were denied. Yet since then they have all, without exception, been abundantly confirmed. Some of these facts, however, remained unacknowledged for so many years, that the original record of them was forgotten. These have proclaimed themselves in ova of some of the lower animals, and observers are publishing them as quite new, though really no more than confirmations of facts first observed in the mammiferous ovum, and recorded in the *Philosophical Transactions* many years before.

Up to the period when I communicated to the Royal Society the second series of those Researches, entire ignorance of the time *post coïtum* when the ovum leaves the ovary had so completely prevented the obtaining of ova from the Fallopian tube, that nothing was known of the essential part of the mammiferous ovum between its expulsion from that organ, and a comparatively advanced condition of it in the uterus. By a determination of that time the hindrance in question was removed; it was thus made comparatively easy to procure ova from the Fallopian tube, in one of the Mammalia at least—the Rabbit. And very soon afterwards a work by Professor Bischoff appeared in Germany on the mammiferous ovum, acknowledging that Barry seemed to have been right in his announcement that the time *post coïtum* when the ovum of the Rabbit usually leaves the ovary is about nine or ten hours.*

To determine the time in question, was a task requiring a great deal of patience, and attended with difficulties of no common kind. But in the course of that inquiry I became acquainted with the fact that there was another period also in the existence of the mammiferous ovum regarding which nothing whatever had been ascertained,—the period intervening between the coïtus and the expulsion of the ovum from the ovary. I saw changes then taking place in the ovarian ovum, without a knowledge of which it is impossible to understand the ovum in any of its future phases. And it is mainly to what was noticed by myself during the inquiry now referred

* Or words to this effect. I write from a part of the country where the book is not obtainable.

to in that dark and previously unexplored period, that I owe my observation of nearly all the facts just mentioned; and any one of these would have repaid the labour. Had Bischoff duly examined the ovum after the coïtus and before its expulsion from the ovary, for which nine or ten hours afford ample opportunity, he would have seen it becoming more and more prepared for fecundation, might perhaps have met with it at the very moment of this change, and would at all events have had the opportunity of witnessing the effects thereof in their most incipient stages. He would then have understood the ovum better in the Fallopian tube and uterus, and could not have denied facts which have since established themselves in ova of some of the lower animals, notwithstanding the obscuring yelk, and in spite of all the outcry which Bischoff raised against my announcememt of them.

Thus while some laughed at what I maintained regarding the germinal spot, they gave drawings shewing that at the very same time they had divisions and sub-divisions of this mysterious body before their eyes; obscured however, in the ova they examined, by a quantity of yelk not present in a solid form, in the mammiferous ovum. Hence the importance of examining the latter at the early period just mentioned. And I now have the satisfaction to see that the illustrious names of Von Baer and Johannes Müller may be added to those who at length find just what I had described as seen in the Mammalia, that the germinal spot, dividing, furnishes the nuclei of the cleft yelk-balls.

The importance of the nucleus of the cell, the part it takes in producing secondary deposits, and its divisions for the production of young cells, I believe to be now doubted by very few of those who have really made adequate inquiry. Yet up to the time when these facts concerning the nucleus were recorded in the *Philosophical Transactions*, no one had questioned the views of Schleiden and Schwann,—that after the formation of the cell-membrane the nucleus either "remains unaltered," or "as a useless member is absorbed." Thus Schwann, when discussing the question, whether the germinal vesicle is a young cell, or the nucleus of the yelk-cell, remarked: "If it be the first, it is very probably the most essential foundation of the embryo; but if it be the nucleus of the yelk-cell, its importance ceases with the formation of the yelk-cell, and according to the analogy of most cell-nuclei it must subsequently be either entirely absorbed, or continue for a time without forming any new essential object."*

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My observation that the spermatozoon penetrates into the interior of the ovum, after having been by some neglected and by others denied for about a dozen years, and even as lately as in 1852 being ridiculed by Bischoff as "born of the imagination," has at length been fully confirmed; and this in two quarters, by inquirers acting quite independently of, and unknown to one another,—in animals, moreover, not far from the lowest in the scale, my own researches having been made at the other end of the animal kingdom in the highest class—Mammalia. One of these confirmations was made in this country by Dr Nelson, the other in Germany by Dr Keber. The researches of the former were on ova of an Entozoon, those of the latter on ova of the fresh-water Mussel. Nelson's paper was published in the *Philosophical Transactions* for last year;† that of Keber has been published in a separate form.‡ It is impossible to read the accounts given by these observers without feeling the fullest confidence in their observations, made and repeated as they evidently were with care and patience that leave nothing in these respects to be desired.

It was found by Nelson, that the spermatozoa penetrating each ovum of the Entozoon he examined were in considerable number; but by Keber, that only a single spermatozoon penetrated the ovum of the fresh-water Mussel. Nelson is one of those who now find in animals at the other end of the Animal Kingdom what I had shewn in Mammalia, that the germinal spot, dividing, furnishes the nuclei of the cells out of

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* "Mikroskopische Untersuchungen über die Uebereinstimmungen in der Struktur und dem Wachsthum der Thiere und Pflanzen." Berlin, 1838–9. S. 660.

† "*The Reproduction of Ascaris Mystax.* Phil. Trans. 1852, Part ii.

‡ "*De Spermatozoorum Introitu in Ovula.*" Königsberg, 1853. (The observations were on *Unio* and *Anodonta*, and made in 1852.)

which arises the new being; an opinion which, as will presently be shewn, is that of Keber also.*

Keber describes the penetration of the spermatozoon into the interior of the ovum in *Unio* and *Anodonta*, through an aperture formed by dehiscence of its coats, analogous to the micropyle in plants; and he refers to an observation in ova of several species of Holothuria made by Professor Johannes Müller, and communicated by him to the Academy of Berlin in 1850 and 1851, of what he (Müller) considered as very much resembling that micropyle. The orifice found by Keber to form for the entrance of a spermatozoon into the Mussel's ovum, seems to correspond to that seen by myself to have formed for the same purpose in the ovum of the Rabbit; in which orifice I saw and delineated what I believe to have been the head-like extremity of a spermatozoon on the point of uniting its hyaline nucleolus with that of the germinal spot. Neither Keber nor Nelson, it is true, saw any such immediate and close connection between the fecundating element and the germinal spot. Nor do I think that this was essential, seeing that in the ova they examined, the yelk enters largely into the formation of the new organism; while in the mammiferous ovum (the subject of my observations) it is the fecundated germinal spot alone that forms it. Hence they did not trace the fecundating element beyond the yelk. Nelson describes the spermatozoa as undergoing liquefaction in the yelk, the germinal spot furnishing the nuclei to effect cleavage of the latter. Keber saw the spermatozoon, or rather what he terms the nucleus of its head-like extremity, to divide into nucleoli in the yelk. He acknowledges his inability to solve the question, in what relation these nucleoli derived from the spermatozoon stand to the pellucid nuclei of the yelk-balls; which nuclei—according to Vogt, Von Baer, Lovén, Johannes Müller, and others—have their origin in the germinal spot.† But after recapitulating the results obtained, he concludes from the observations of Johannes Müller‡ and his own, that neither the germinal

* Even Nelson, however, was not aware of my having recorded the penetration of the spermatozoon into the ovum as an established fact; though Keber was fully aware of it, and does me the justice to quote all that I had written in the *Philosophical Transactions* on the subject, both in 1840 and 1843.

† Keber, *loc. cit*, p. 46.

‡ Müller's Archiv, 1852.

spot nor the spermatozoon really disappears, "but that both enter into the formation of the nuclei of the new organism."* And he finally says: "Through observation alone can it be decided, whether the nuclei arising out of the spermatozoon and the germinal spot unite to pass into the embryonic cells."† That such union is what takes place in the mammiferous ovum I think was shewn by my own observations in 1840, when it was recorded that, before the cleavage of the yelk begins, the hyaline centre of the germinal spot is determinately held by the retinacula, up to a certain time, as near as possible to the surface of the ovary; that an orifice is formed in the "zona pellucida," at the part where this centre lies; that on one or two occasions I saw this centre of the germinal spot, apparently without any covering from the germinal vesicle,‡ actually protruded into the orifice in the "zona pellucida," as if to meet the fecundating element; and that subsequently the germinal spot passes to the centre of the germinal vesicle, and the germinal vesicle to the centre of the ovum. I added, that the germinal vesicle, which by determinate pressure at the periphery became lenticular, now resumes the spherical form, and that an orifice in the "zona pellucida" is no longer seen. Such alterations suggest the probability of some sudden and important change having been effected in the condition of the ovum. The nature of the alterations is such as to induce the belief, that the ovum has undergone fecundation; the mysterious hyaline centre or nucleolus of the germinal spot having received the fecundating element of the seminal fluid, and having thus been the point of fecundation. And farther, from an observation I published at the same time, it is to be inferred that the fecundating element is the pellucid substance (nucleolus) contained in the head-like extremity of the spermatozoon, a direct union taking place in the mammiferous ovum between this substance and the hyaline nucleolus of the germinal spot. I have already stated why I think such direct union between the spermato-

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* Keber, *loc. cit.*, p. 56. † Keber, *loc. cit.*, p. 111.

‡ I have since recorded the fact, that an orifice is sometimes seen at the corresponding part in other cells. *Phil. Trans.* 1841, Part ii., p. 204, Plates 17 to 19.

zoon and the germinal spot is not essential in ova where the yelk enters largely into the formation of the new being. In the mammiferous ovum, the hyaline centre of the germinal spot, and the hyaline in the head-like extremity of the spermatozoon are both to be considered nucleoli, a mixing or combination of which it appears to me yields the substance out of which is formed the new being; and to this mixing I apprehend is to be attributed the resemblance between the offspring and both its parents.*

Keber justly deprecates theory when it is attempted therewith to make up deficiencies left by superficial investigation, and gives examples of it in two papers recently published in Germany on this very subject, shewing the conclusions they contain to be valueless, annihilated as they are by positive observation. The author of one of those two papers is Bischoff,† that of the other, Kölliker.‡

I fully adhere to what I first published in 1839, and again recorded as established and extended by means of higher magnifying powers in 1840, that in the mammiferous ovum, the mulberry-like body into which the fecundated germinal spot has divided, contains a cell larger than the rest—a sort of queen-bee in the hive; and that the embryo arises out of the nucleus of this cell, in the form at first of the so-called "primitive trace," and "chorda dorsalis."

This origin out of the nucleus of a cell (instead of, as had been supposed, in the substance of a membrane) explains why in the higher animals, the embryo is formed at one point of the yelk surface. Farther, I maintain the accuracy of all the other "marvellous figures," as Bischoff calls them, given by myself of mammiferous ova from the uterus. Before recording the results referred to in this communication I had sacrificed about 150 rabbits, which yielded 181 ova from the uterus, 230 from the Fallopian tube, and an uncounted number from the ovary,—a large proportion of the latter belonging to the dark period pioneered in the inquiry above mentioned. And

* See also my remarks on this subject in Müller's Archiv for 1850, Heft vi.

† "Theorie der Befruchtung und über die Rolle welche die Spermatozoiden dabei spielen," in Müller's Archiv, 1847, s. 422.

‡ "Beiträge zur Kenntniss der Geschlechtsverhältnisse."

I cannot refrain from here repeating that he who, in researches on the mammiferous ovum, does not very minutely, and very patiently, and again and again, examine ova during that period, i.e., *in the ovary post coïtum*, is quite incapable of understanding them in the uterus or Fallopian tube.

Another cause of ignorance that recent works by a German author shew still to exist regarding the mammiferous ovum in the Fallopian tube and uterus, is its perishable nature. This inconvenience is felt chiefly in examining ova the essential part of which has left the centre and reached one side; for the chances are against that side being directed towards the eye. You cannot turn the ovum round and round without destroying it, for to a body so delicate it is impossible, even with the finest hair pencil, to apply an equally delicate manipulation. And supposing you at length find one having the essential part directed upwards, a few minutes will not suffice for the examination, of which some figures that have been published afford ample proof. Some medium is required in which the examination may be more perfectly accomplished. The smallest ova from the Fallopian tube and uterus it was my practice to view imbedded in some of the mucus taken from those parts, after I had excluded the air in a manner formerly described.* For any but the smallest a transparent fluid is required. I tried a large number, and all were found unsuitable excepting one. That one was a saturated aqueous solution of Kreosote, which I still most particularly recommend as a medium in which the ovum may be examined day after day, and may be even delineated at the end of several days.†

Besides the facts and conclusions already referred to in this communication, my papers on Embryology will be found to contain others, among which are the following, viz. :—

8. The existence and mode of origin of a vesicle not previously described, which I shewed to be common to the ova of vertebrated animals, and to constitute the foundation of the Graafian follicle, a vesicle which I followed upwards from

* *Phil. Trans.* 1839, Part ii., pp. 365, 367.

† *Phil. Trans.* 1839, Part ii., p. 345, Plate 8, fig. 138, a drawing taken after the ovum had lain in Kreosote water for three days.

the minuteness of $\frac{1}{100}$th of a line, and proposed to call the *ovisac.*

9. The existence and mode of origin of ban dsregulating the movements of the mammiferous ovum in the ovary, and rendering gradual its expulsion from that organ; which bands I termed the *retinacula.*

10. The existence of vesicles under the mucous membrane of the uterus in the Rabbit, containing a mulberry-like body, one of which I had seen revolving on its axis.

In rabbits, of which he sacrificed about thirty in his researches, Keber met with vesicles in large number, each of which contained a revolving mulberry-like body, revolving by means of cilia; and he found the position of these vesicles to be most frequently somewhere in the cavity of the abdomen. He satisfactorily shews such vesicles to have been expelled from the ovary, and mentions facts that induced him to believe them to be ova.

I have no doubt that this indefatigable observer is quite right in considering the revolving body in such vesicles to be the essential part of an unfecundated ovum.* There is one point, however, on which I am compelled to differ from him in his conclusions, without for a moment questioning the accuracy of any of his observations. He is evidently one who, desiring only to arrive at truth, will not feel hurt by the suggestion I am about to offer. So far from this, indeed, his work already mentioned contains a special invitation on the subject.

I do not believe the membrane of the vesicles in question to be the vitellary membrane ("zona pellucida"); and for the following reasons.

In some of the Mammalia it is so common to meet with ova that have escaped from the ovary during the rut without fecundation, that with others I believe this to take place generally in the class. Such unimpregnated ova, however, I have usually found to be *accompanied by their ovisacs;* which also I have no doubt takes place generally in this class

* It was erroneously stated in a short notice which appeared in the last number of this Journal, that Keber had considered the vesicles in question to be *fecundated* ova.

of animals. Then the first change after their expulsion from the ovary seems to be the disappearance by liquefaction of the "zona pellucida;"* which is not surprising, for it arises as a mere fluid,† and seems never to reach more than a gelatinous consistence in the ovary. In the Rabbit, when the ovisacs thus expelled with their unimpregnated ova do not pass into the cavity of the abdomen, but enter the uterus, they become connected therewith by bloodvessels, and seem to exist for a while therein as parasites. The mulberry-like revolving body they contain, no doubt consists of the group of cells arisen from nuclei into which the germinal spot divides and subdivides; which divisions and subdivisions, therefore, I believe to take place without fecundation. But when this happens, *they do not lead to the formation of a cell larger than the rest*, which I have compared to a queen-bee in the hive. The epithelium with vibrating cilia seen by Keber on the inner surface of the membrane of these vesicles, appears to me to have been what Von Baer denominated the membrana granulosa; each granule having become an epithelial cell. *The membrane of the vesicles in question, therefore,* lined by such an epithelium, *I believe to be that of my ovisac.*

From these remarks it will be seen that, though not taking the same view as Keber on one point, I believe that physiologist to have shewn that the mulberry-like body described by myself in the *Philosophical Transactions* for 1839, as revolving on its axis, was the essential part of an unfecundated mammiferous ovum. That observation of mine was quite incidental, but I have the satisfaction to know from Bischoff's own remarks that it was that observation that led him to look for a revolving body in the ovum of the Mammalia,‡ and which he was so fortunate in one instance as to find. It was the fibrous membrane,—the layer of granules on its inner surface,—the connection by bloodvessels with the uterus,—

* See a drawing I gave of such an ovisac from the infundibulum in the Hog. *Phil. Trans.* 1839. Part ii., Plate 5, fig. 102, *h* and *f*.

† *Phil. Trans.*, 1838. Part li., Plate 8, fig. 70, *f*.

‡ See a paper of his in Müller's Archiv for the following year, 1840.

and the absence of anything like a "zona pellucida,"—that made me hesitate to consider the mulberry-like revolving body as the essential part of an ovum; for, as regarded that mulberry-like body, I stated the resemblance it bore to an ovum to be perfect. There certainly were not wanting inducements that would have made it very agreeable to one who had shewn *that cleavage of the yelk takes place in the ovum of the Mammalia*,* could he have extended from the ovum of some of the lower animals to that of the highest class, the remarkable phenomenon of *rotation* also. But I contented myself with the remark: "It remains to be discovered whether the mulberry-like structure with its germ in the ovum of Mammalia also performs rotatory motions."†

Among the objections anticipated by Keber as likely to be raised by others against his view, that these vesicles are ova, is the fact that their membrane is fibrous,—a fibrous structure never having been discovered in the "zona pellucida." Now this objection I have just met by my statement that the membrane in question is not the "zona pellucida," but the ovisac. For there can be no doubt that a multitude of particles I figured as dividing and subdividing to enter into the formation of the ovisac (before the existence of what could be denominated membrane), and leaving remarkable centres which also I delineated, were the elements of fibre.‡

Another objection that might be raised against Keber's view has reference to *size;* an objection fully provided for by my idea that the vesicle in question is not the vitellary membrane but the ovisac.

Keber observed, that in the membrane of one of the vesicles containing a revolving body there had been formed an orifice; and this by an arrangement of the fibres too regular to admit of the supposition that the orifice was accidental. This orifice I believe to exist before the expulsion of the ovum from the ovary; an opinion founded on the following observation

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* *Phil. Trans.* 1839, Plate 6. † *Phil. Trans.* 1839, p. 357.

‡ See especially in the *Phil. Trans.* for 1841, Plate 25, figs. 164 to 173. And see a paper of mine in this Journal for October 1853, "On Animal and Vegetable Fibre."

along with others; viz, that "when the discharge of the ovum from the ovary is very near, that portion of the Graafian vesicle directed outwards is seen to have been removed."* After recording which, I gave a drawing of a Graafian vesicle about to discharge its ovum, that Graafian vesicle having been carefully dissected out of the ovarium, and so placed that the compressor might act upon it laterally, when an appearance was obtained which I cannot help believing to have presented the orifice in question.† And I have no doubt that in the Mammalia this orifice is intended as well for the admission of the fecundating element, as also for the expulsion from the vesicle in question (ovisac), while in the ovary, of the fecundated ovum.‡ For my observations shew that fecundation of the mammiferous ovum takes place in the ovary.§

And here I am reminded, not only that the ovisac at its origin, like other primary cells according to my observations, is always elliptical and not round, but that as its size advances (during which it becomes more spherical) it is often met with *somewhat tapered at one end; which end is often found to be the position of the minute ovum.*‖ Now as possibly the orifice in question may be intimated at an early period, and before the ovisac becomes covered with bloodvessels to produce a Graafian follicle, I recommend inquirers to seek for it chiefly at the smaller end, which they will no doubt find directed towards the surface of the ovary.

I have just shewn that in Mammalia, when unfecundated ova leave the ovary, the ovisac usually escapes with them. It is deserving of notice that in this class of animals the leaving of the ovary by *fecundated* ova seems to be always

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* "Researches in Embryology, Second Series." *Phil. Trans.*, 1839, p. 317.

† *Phil. Trans.*, 1839, Plate 5, fig. 95.

‡ See a drawing I gave of the ovisac with its orifice after the expulsion of the ovum. *Phil. Trans.*, 1839, Plate 5, fig. 98.

§ It must not be inferred that my observations of Spermatozoa in the interior of ova *met with* in the Fallopian tube, made me suppose fecundation of such ova to have taken place after their expulsion from the ovary.

‖ "Researches in Embryology, First Series." *Phil. Trans.*, 1838, Plate 8, fig 74 *h*.

followed by the expulsion of the ovisac.* So that in Mammalia the ovisac appears to escape either with the ovum or after it.†

This brings me to conclusions, which I venture to offer as perhaps sufficient to supply analogies long sought for by Physiologists in vain, viz.:—

1. That in the Mammalia the vesicle I described as the foundation of the Graafian follicle, and termed the ovisac, does not remain permanently in the ovary, but is expelled and absorbed.‡

2. That in the Bird the ovum, when escaping from the ovary, is accompanied by the corresponding vesicle,—the ovisac, and that *the ovisac becomes the shell-membrane of the Bird's egg;* the Bird's "egg," as we call it, being thus a shelled ovisac, and the contained "yelk," as is known, being the true ovum.

3. That the expelled and lost ovisac in the Mammalia therefore corresponds to the shell-membrane in the Bird.

4. That after the formation of the ovum, the albuminous contents of the ovisac in the Mammalia correspond to the albumen in the Bird's "egg."

5. That my retinacula in the Mammalia after all find their analogue in the chalazæ of the Bird; and that both have their origin in the granular contents of the ovisac, which, at an early period, are in appearance just the same in both.

6. That the shell-membrane of the Bird's "egg" is thus a primary cell.

(We next come to the "zona pellucida" in the ovum of Mammalia, known to correspond to the vitellary membrane

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* In the Rabbit this expulsion of the ovisac seems to take place in three or four days after the fecundated ovum has escaped. In the Sheep and Goat not so soon; for it appears to me to have been this vesicle (my ovisac) that Dr Pockels refers to in these animals, as remaining in the incipient *corpus luteum* eight days and more after the expulsion of the ovum from the ovary.—(Müller's Archiv, 1836, Heft ii., s. 203.)

† The ovisac escapes freed from its vascular covering; the latter alone entering into the formation of the *corpus luteum.* "Researches in Embryology, Second Series." *Phil. Trans*, 1839, § 261, Plate 5, fig. 98.

‡ And, therefore, as I formerly shewed, can take no part in the formation of the *corpus luteum.*

in the Bird's "egg;" which latter I found to be *originally* a perfect "zona pellucida,"—its consistence almost fluid.*)

If the analogies now pointed out be admitted, they will of course be found applicable, more or less, to the ova of other animals, as well as to the ovum of the Bird.

They will also serve to explain the occasional presence in the Bird's "egg" of more than one yelk (ovum); obviously referable to the same cause as that (to be presently mentioned) sometimes producing in Mammalia several ova in one Graafian follicle. For, it must be remembered, the foundation of the Graafian follicle in Mammalia is the ovisac; and the ovisac I have just stated my belief to become the shell-membrane of the Bird's "egg."†

(The existence of my retinacula is actually among the facts that Bischoff has denied. I must confess that this appears to me to imply investigation so superficial, that I do not wonder at denial in the same quarter of facts requiring far more profound research. For instance, the penetration of the Spermatozoon into the ovum, my observation of which,—though the fact was stated to have been demonstrated to an Owen and other men of eminence,—Bischoff ridiculed as "born of the imagination." Those who, from such denial, have been led to doubt the existence of the retinacula, may be convinced of it without the trouble even of opening a Graafian follicle, by simply examining the latter in the Rabbit, or still better in the Ferret (*Mustela Furo*), from the exterior of the ovary with a good pocket lens.)

I cannot refrain from again referring to the egg-like form, *tapered at one end* (this end often found to be the position of the ovum), among my figures of the ovarian ovisac, which I believe to become the shell-membrane of the Bird. For such an early appearance of that tapered form suggests the

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* *Phil. Trans.*, 1838, Plate 5, fig. 25.

† In the Dog, I have frequently seen three, and not rarely four ova in one Graafian follicle; and in the Ferret, such instances of plurality are still more frequent.

thought, that the shape characteristic of the Bird's "egg" is first intimated there—in the ovary. And if so, the shape in question is after all not peculiar to the "egg" of the Bird; for it happens that the ovarian ovisacs to figures of which I am now referring, were seen in one of the Mammalia.*

From the observations of Von Baer and R. Wagner, in invertebrated animals, and my own in two classes of the Vertebrata, I concluded, in 1838, that the germinal vesicle and its contents constitute, throughout the animal kingdom, the most primitive portion of the ovum.† Subsequent research in the Bird enabled me to record this as an established fact.‡ And as the positions to be assigned to the several parts of the ovum, in the language of "cells" have not yet been satisfactorily determined, I will here, in that language, state my own recorded observations.

There first exists a pellucid particle, which becomes an elliptical "cytoblast." Out of the nucleolus of this "cytoblast" there arise the germinal vesicle and its contents; and then the outer part of the "cytoblast" forms the membrane of a cell,—my ovisac. To this cell the germinal vesicle is related as the hollow nucleus to a ganglion globule. Out of the granular contents of the cell now mentioned is formed, first, a portion of the yelk around the germinal vesicle, and then, around the incipient yelk, the vitellary membrane—the "zona pellucida" of Mammalia—which arises in a semi-fluid form.

The occasional presence of two or more ova in a single ovisac, is to be explained as follows. It sometimes happens that *before the formation of the membrane of the ovisac*, the nucleolus of the "cytoblast" has divided into two or more parts, each of which becomes a germinal vesicle: and then the membrane of the ovisac, subsequently formed, is made to include the whole of these,—and we have in one ovisac two

* The Dog. *Phil. Trans.*, 1838, Part ii., Plate 8, fig. 74, *h.*

† "Researches in Embryology," First Series. *Phil. Trans.*, 1838, Part ii., § 93.

‡ *Phil. Trans.*, 1841; Part ii., Plate 25, figs. 165 to 173.

or more ova.* For out of the contents of the ovisac a yelk arises around each germinal vesicle, and then a vitellary membrane ("zona pellucida") around each yelk. This, as already said, explains the presence occasionally, not only of several ova in a Graafian follicle, but also of more than one "yelk" (ovum) in the Bird's "egg."

Notes on the Life of the celebrated Dominique-François-Jean Arago, Perpetual Secretary of the Academy of Sciences, Member of the Board of Longitude, and Grand Officer of the Legion of Honour, &c. &c.†

The death of DOMINIQUE-FRANCOIS-JEAN ARAGO has cast a gloom over the city; and the announcement of this melancholy result, which we deplore and record with sadness, was received with a heavy, heartfelt regret by his fellow-citizens. The last of one of the bright ornaments of the true old school of science is now no more. The philosopher, the man of of science, the friend of truth, the judicious and wise counsellor, has left this earth full of years and full of honours, having devoted a life of fifty years with a steady determination to improve his country, and to advance his fellow-creatures. Never during this long period has he allowed his activity to be interrupted, nor has he ever flagged or even recoiled from anything that remained to be done. The lofty aim of the departed philosopher was ever to unfold the wonder of Divine skill, and to develop the laws of Divine government. His immortal writings will shed a light on the paths of science, as long as the world is governed by the same laws.

It is our office to give "honour due" to all such manifestations of intelligence; and whilst endeavouring to shew the extent to which the mental powers of M. Arago were effec-

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* An instance of this, met with in the ovary of a Bird, shewing two young germinal vesicles about to be included in the same ovisac (and thus to explain the presence of two "yelks" in the Bird's "egg,") will be found in the *Phil. Trans.* for 1841, Part ii., Plate 25, fig. 165, in the only body in this figure not marked by a letter.

† From the *Athenæum, Quarterly Review, Commonwealth* Newspaper of Glasgow, and *Comptes Rendus.*

tive in gaining for mankind new truths from Nature,—we have also to examine the degree in which such a mind as his was influential, by suggestion and by example, in elevating the spirit of his age.

The long series of sufferings which brought M. Arago to the grave, at a not very advanced age, commenced by diabetes, not very intense, but which rapidly exhausted his strength. The diabetes gave way to another malady, which continued slowly the lamentable work of decomposition and destruction, and which was terminated by dropsy in the chest, with suffusion and suffocation, swelling of the extremities, &c. Everything announced an early death; but it was hoped that the efforts of science, and the devoted and tender care of an afflicted family, would prolong his precious existence some days longer. The illustrious patient rose on Sunday, 2d October, afternoon, and dressed himself. He went to bed again at five o'clock, and took a slight repast. Some minutes after, he asked to be raised a little, and to be placed in the middle of his bed; then all at once he cried, pressing his breast, "I am suffocating! I am suffocated!" His attendants hastened to him, and proceeded to light a lamp the better to ascertain his state; but before this could be done the death-rattle was heard, and in less than five minutes after François Arago was dead. The great man has now drawn his last breath. The stillness of death surrounds him, accompanied with deep silence and pensive sorrow, sweetly mingled with the full assurance of hope. The close of such a life is full of solemn and soul-subduing tenderness. The living soul has gone—it has gone to the sweets of eternity—the eternal home of his God and his Saviour. His death is an act of his Maker, designed for the good both of the living and dead.

During all his malady his lofty intelligence was not obscured for an instant. Scarcely three weeks ago, he was labouring at a new edition of his celebrated work on Thunder; he recalled what he had read, dictated precious additions, caused difficult researches to be made, &c.; and he asked M. Babinet to prepare for him a table of the best determined numbers of the length of undulations, in order that he might complete an important paper on Light; he corrected the proofs of his Biographical Notice of Monge; he terminated his Notice on Planets, &c.; he discussed with perfect lucidity; he made profound remarks, &c. The pain of his malady affected him a good deal less; every week there was a violent conflict between his conscience—delicate to excess—and his physical weakness, the energetic refusals of physicians, and the pressing solicitations of his family; more than once it was impossible to restrain him, and he was seen almost dying endeavouring to examine a voluminous correspondence, as if he wished to yield the last sigh at the post of duty.

The funeral of M. Arago took place with much pomp. The remains of the deceased were transferred to a *chapelle ardente*, under the principal gate of the Observatoire, where his friends were permitted to sprinkle holy water over them. In the meantime a brigade of infantry, under the command of General Renault, drew up at both sides of the avenue of the Luxembourg, where they were shortly joined by 200 men of the 18th battalion of the National Guard. The rain, which had set in early in the morning, fell without ceasing, which, however, did not prevent thousands from assembling on the avenue and in the streets through which the *cortége* was to pass. At noon the procession began to move. It was opened by two companies of the 6th regiment of infantry, the band playing a solemn dirge; next rode the General, accompanied by his staff, and an escort of horse *chasseurs*, attired in their new uniform, green and black, with woollen bonnets, which gave them the appearance of Cossacks. Then came two other companies of infantry, the detachment of National Guards, two mourning coaches, containing the clergy of St Jacques du Haut Pas, a modest hearse drawn by two horses, and followed by M. Emmanuel Arago, the son of the deceased, other members of his family, his numerous friends, the members of the Académie des Sciences, of which M. Arago was perpetual secretary, and a crowd of his political adherents, among whom were M. Garnier Pagès, his colleague of the Provisional Government in 1848; M. Pagnerre, one of its secretaries; M. Bastide, Minister of Foreign Affairs in the Executive Government under General Cavaignac; M.

Guinard, Colonel of the Parisian Artillery, who, having joined M. Ledru-Rollin in the demonstration of the Conservatoire des Arts des Métiers, on the 13th of June 1849, was sentenced to banishment, but was subsequently pardoned by the Emperor; Messieurs de Lasterie, Jules Favre, Flandin, Lherbette, and other members of the late Legislative Assembly. Two Imperial state-carriages came next, in which were seated Marshal Vaillant, Grand Marshal of the Palace, and M. Ducos, Minister of Marine, who directs *ad interim* the department of Public Instruction in the absence of M. Fortoul. Two battalions of infantry closed the march. The *cortége* descended the avenue of the Luxembourg, passing close to the spot where Marshal Ney was shot, and proceeded to the Rues de l'Est, Val de Grace, and St Jacques, to the church of St Jacques du Haut Pas. The edifice being small, very few except the family and immediate friends of the deceased could be present at the religious service, which was performed by the parish priest, assisted by a numerous body of the clergy. At one o'clock the *cortége* resumed its march, in the same order, for the cemetery of Père-la-Chaise, passing through the Rues St Jacques and Soufflot, the square of the Panthéon, the Rues Clovis, Fossés, St Victor, and St Bernard, the Quay St Bernard, the Bridge of Austerlitz, the Place Mazas, the Boulevard Contrescarpe, the Place de la Bastille, and the Rue de la Rouquette. It was said that this morning when the *Moniteur* announced that the Government intended to honour the memory of the illustrious deceased, the chiefs of the Democratic party met, and resolved to recommend their friends not to appear at the funeral. Either their orders did not reach in time or were disobeyed, for the greatest number of those who formed the *cortége* belonged to that party, with whom M. Arago did not sympathise, and who were in arms against him in June 1848. They awaited the arrival of the procession in wine-shops and coffee-houses along the line of march, and joined it as it passed.

M. Ranal, a former pupil of the Polytechnic School, and one of the young race of philosophers in whom Arago had taken a lively interest, pronounced over the tomb of his master the following brief but touching eulogium:—

"Illustrious Master—Much-loved Master—Noble Citizen

—It is a duty, and at the same time a very sad honour, for me to express a sentiment which now fills every heart. Thy constant solicitude for the progress of human knowledge has always induced thee to take the young by the hand, and to inspire them with thy passion for science. On the eve of thy death, the last word which thou spoke to us was, 'Work; work diligently.'

"This sublime lesson will remain engraven on the heart of every young philosopher. They will feel compelled to follow the path which thy genius has opened. In falling asleep into immortality, thou hast desired to teach them that work is the only means of doing service to their country and humanity. Thanks on their behalf. Adieu, in the name of youth—in the name of its admiration of thee—of its love for thy memory—I tell it thee—you may count upon it. Adieu!"

M. Arago was born in the village of Estager, near Perpignan, in the Pyrenees, on the 26th of February 1786, and he died at the Observatory in Paris on Sunday the 2d of October; consequently he was in the 68th year of his age. Gifted by nature with powers of a higher order than those which are usually bestowed on man, he possessed or acquired habits of industry which enabled him to develop them in all their fulness. Like the majority of really great men, he was the architect of his own fortune. He owed little to fortuitous circumstances; and, indeed, achieved much when serious obstacles were put in his path. Suffering no difficulty to bear him back, he rose always superior to misfortune; and, with great honesty of purpose and indomitable independence, he laboured towards the end which he had in view. From his boyhood this appears to have been his character. When a youth in the College of Perpignan, his ambition was excited by the appearance of, and the respect paid to, an engineer *en chef*. He learned that this honour might be obtained by means of the Polytechnic School, and that a searching examination in mathematics must be gone through to ensure his admission to that institution. François Arago then seriously commenced mathematical studies, and in 1804 he entered the school in question with the highest honours.

In 1806, when only twenty years of age, so much had he distinguished himself, that he was appointed a secretary of the Board of Longitude; and almost immediately afterwards, his acquirements having attracted the attention of M. Monge, he was recommended as the fitting assistant to M. Biot for undertaking the measurement of an arc of the meridian in Spain. This scientific labour was considerably advanced in 1807, when Biot returned to Paris, leaving Arago in charge of the important work.

In the execution of this arduous work, MM. Biot and Arago were stationed on the summit of Mount Galatzo, one of the highest of the Catalonian branch of the Eastern Pyrenees, while MM. Chaix and Rodriguez established themselves on Mount Campecey in Ivica, one of the Balearic Islands. In this cold and desolate position the astronomers remained for several months, keeping up a constant communication with each other by means of fire signals, lighted up at particular intervals. Here they were exposed to various kinds of privations and particularly to the fierce blasts which sweep over these lofty solitudes. The huts in which they dwelt were frequently blown down, and their lives endangered. But these calamities were nothing compared with the dangers to which they were exposed from the ignorance of the people. Before Arago had finished his work, his colleague, M. Biot, had returned to Paris, and war had broken out between France and Spain. The fires which blazed at the signal-stations were regarded by the ignorant mountaineers as telegraphic despatches informing the invading army of the movements of the patriots. Arago was therefore denounced as a spy, and it required all the courage and skill which he possessed to escape the dangers to which he was thus exposed. Born near the Spanish frontiers, he spoke the same dialect which prevails round Mount Galatzo, and, disguised in the mantle and red cap of a Catalonian mountaineer, he effected his escape to Majorca, where he found shelter, along with his papers and instruments, in the fortress of Belver. After completing in this retirement his geodesical calculations, he obtained liberty, on the condition of proceeding to Algiers, which he did by the first opportunity. On his passage from Algiers to Marseilles, in an Algerine frigate procured for him by the French consul, the ship, when in sight of the French coast, was captured by a Spanish privateer. Arago was carried a prisoner to Catalonia, confined in the fortress of Rosas, and afterwards sent to the hulks at Palamos. Indignant at the insult offered to his flag, the Dey of Algiers demanded and obtained from the Spanish Government the liberation of Arago, and the whole of the crew. Anxious to return to his country, Arago again set sail for Marseilles, but, when about to enter the harbour, a violent hurricane drove the vessel to sea, and cast it on the rocky shore of Sardinia, then at war with Algiers. Being thus prevented from landing, the vessel in a shattered condition reached Bougia, on the coast of Africa, about three days' journey from Algiers. Assuming the costume of a Bedouin Arab, and protected by a marabout, Arago, travelling on foot, reached Algiers in safety. Unfortunately, however, for our distinguished philosopher, the former Dey, who had rescued him from the hulks at Palamos, had fallen a victim in an insurrection, and was succeeded by a man of brutal character, who refused to permit Arago to return to France. The French consul, however, succeeded in obtaining his release, and Arago was safely landed at Marseilles, in the month of August 1809, the vessel in which he had embarked having narrowly escaped from an English cruiser, which had given it chase.

Upon the death of the celebrated astronomer Lalande, in 1809, Arago, though only twenty-three years of age, was, in opposition to the standing rules of the Academy of Sciences, appointed to the vacant place in the section of Astronomy; and, after a few years, he entered upon that brilliant career of discovery which has immortalized his own name, and added to the glory of his country. Although Arago, when a pupil at the Polytechnic School, had voted against the assumption of the consulate for life, yet Buonaparte, who knew how to value an honourable man, never resented this act of hostility, and remembering the courage of the young philosopher, he appointed him one of the Professors of the Polytechnic School, and subsequently Director of the Imperial Observatory, in which he resided till his death.

Numerous researches, experiments, and inventions, have immortalized his name; but his principal claims to renown, are, 1*st*, magnetic and rotatory polorization; 2*d*, magnetism by the action of currents; 3*d*, magnetism by rotation. François Arago was an encyclopædic genius. Sciences, letters, social economy,—his vast intelligence embraced all with an ever equal superiority. At the Ecole Polytechnique, the Académie, the Observatoire, and the Municipal Council, the extent and variety of his knowledge, and especially the astonishing faculty of assimilation, vulgarization, and application, with which he was gifted, placed him everywhere in the first rank. As an orator, he was distinguished by a marvellous lucidity of exposition—by the abundance, facility, and picturesque energy of his delivery. As a writer, he was distinguished by clearness, elegance, and a sustained firmness of style—qualities which place him on a par with the most distinguished of our prose writers. "He possessed," says Timon, "the secrets of the language, as well as the secrets of the heart." "Never," says one of his biographers, "did human head undertake, without breaking, such an enormous mass of labour." Arago considered every man idle who did not work fourteen hours a-day. Days of that kind were, however, for him days of repose. He was engaged at the same time in chemistry, physics, mechanics, astronomy, natural history, philosophy, and literature. He was a member of all the scientific or industrial associations in the world; his study was literally encumbered with plans to examine, and memoirs to analyse. The Government, the municipality, the establishments of public utility, and even private industry, found in him an active and disinterested counsellor and guide. His time was given to all things and to everybody. At the same time that he had an eye to what passes above, he had one to what takes place here; and amidst all his absorbing and varied occupations he found time to shew himself one of the worthiest and most charming talkers in the saloons of Paris.

Arago's first work was read before the Institute on the 24th of March 1806. It was an investigation, in which he was assisted by Biot, "On the Affinities of Bodies for Light, and particularly on the Refracting Powers of different Gases." With M. Petit, Arago investigated "The Refractive Powers of certain Liquids, and of the Vapours formed from them. With Fresnel, he examined "The Action which the Rays of Polarized Light exercise upon each other:"—and on those subjects much valuable matter will be found in his Memoirs. Omitting from our list those Astronomical notices which regularly appeared in the *Annuaire*—and which, though forming a part of his official duty, manifest, nevertheless, the zeal of the Secretary and subsequent Director of the *Bureau des Longitudes*—we would refer to M. Arago's memoirs "On the Comets of Short Period;" "On the Pendulums of MM. Breguet;" "On Chronometers;" "On the Double Stars;" and on the vexed question, "Does the moon exercise any appreciable Influence on our Atmosphere?" Passing from astronomical subjects, we find several memoirs:—"On Nocturnal Radiation;" "The Theory of the Formation of Dew;" and on allied subjects—as "The Utility of the Mats with which Gardeners cover their Plants by Night;" "On the Artificial Formation of Ice;" and "On the Fogs which form after the setting of the Sun, when the Evening is calm and serene, on the Borders of Lakes and Rivers." Indeed, the whole of the phenomena to which Dr Wells had directed attention in his excellent work "On Dew," was thoroughly investigated by M. Arago.

When we add the memoirs on "The Ancient Relation of the Different Chains of Mountains in Europe," "The Absolute Height of the most Remarkable Ridges of the Cordilleras of the Andes," "Historical Notices of the Steam-Engine," "On Explosions of Steam-Boilers," "Historical Notices of the Voltaic Pile," "those which are connected with the Polarization of Light," "the Phenomena of Magnetic Rotation," and "On the Egyptian Hieroglyphics," we think we indicate labours of a most varied and important character.

For many years, M. Arago, who was the Director of the Observatory at Paris, employed his position in the Chamber of Deputies and elsewhere, to obtain large grants from the state for the use of the institution over which he presided. M. Arago, on the 13th September 1852, proposed to the *Aca-*

démie des Sciences an infallible method of finding out every planet which remained. Since that period several more have been added to the list.*

The French nation may be justly proud of such a man as Arago. We cannot overlook his earnest desire to give to the public all the advantages of the discoveries of science with the least possible delay; and with the utmost freedom from mere technicalities. In 1816, he established, in connection with M. Gay-Lussac, the *Annales de Physique et de Chimie;* and on his pressing representation, on the 13th July 1835, the Academy commenced, in charge of its perpetual secretaries, *Les Comptes Rendus Hebdomadaires.*

In 1830, Arago was made Director of the Observatory; and he succeeded Fourier as a perpetual secretary of the Academy of Sciences. His remarkable activity of mind and

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*1. 1801	Ceres	Piazzi	Palermo.
2. 1802	Pallas	Olbers I.	Bremen.
3. 1804	Juno	Harding	Lilienthal.
4. 1807	Vesta	Olbers II.	Bremen.
5. 1845	Astrea	Hencke I.	Driesen.
6. 1847	Hebe	Hencke II.	Driesen.
7. 1847	Iris	Hind I.	London.
8. 1847	Flora	Hind II.	London.
9. 1848	Metis	Graham	Markrea.
10. 1850	Hygeia	De Gasparis I.	Naples.
11. 1850	Parthenope	De Gasparis II.	Naples.
12. 1850	Victoria	Hind III.	London.
13. 1850	Egeria	De Gasparis III.	Naples.
14. 1851	Irene	Hind IV.	London.
15. 1851	Eunomia	De Gasparis IV.	Naples.
16. 1852	Psyche	De Gasparis V.	Naples.
17. 1852	Thetis	Luther	Düsseldorf.
18. 1852	Melpomene	Hind V.	London.
19. 1852	Fortuna	Hind VI.	London.
20. 1852	Massalia	Chacornac De Gasparis VI.	Marseilles. Naples.
21. 1852	Lutetia	Goldschmidt	Paris.
22. 1852	Calliope	Hind VII.	London.
23. 1853	Thalia	Hind VIII.	London.
24. 1853	Phocea	Chacornac II.	Marseilles.
25. 1853	———	De Gasparis VII.	Naples.
26. 1853	———	Luther II.	Bilk.

unwearying industry, led him without difficulty through an amount of labour which would have overwhelmed an ordinary man. There was a remarkable clearness in his perception of these matters to which his attention was directed. He readily stripped them of any adventitious clouding or mystery by which they might be surrounded, and fearlessly and energetically expressed his convictions. As a writer, we may remark the strong evidences of the latter in his firmness of style; and the clearness of his perceptive faculties is shewn in his lucid eloquence.

In 1834 Arago visited Edinburgh for the purpose of attending the meeting of the British Association. His friend, Professor Jameson, shewed him marked attention. The freedom of the City was granted to him by the Lord Provost, Magistrates, and Council, which he was highly proud of; and he also had conferred on him the honourable distinction of doctor of laws.

It would have been well if Arago had devoted himself exclusively to the pursuits of science and literature, for which he was so eminently qualified. He found himself unable to resist the temptation presented by the revolution of 1830 of entering on the political arena. During the combat of the three days he did his best to stop, through his influence with Marmont, with whom he had long been on friendly terms, the effusion of blood. In the election which took place soon after the fall of the elder branch of the Bourbons, he was elected to the Chamber of Deputies by his department, and at once chose the party to which he attached himself, by taking his place between Laffitte and Dupont (de L'Eure) in the extreme left. From that period till the revolution of 1848 he acted with the same party. On questions of material interest to the country, such as public education, the navy, canals, railroads, &c., he often spoke, and effectively; and it is not yet forgotten, that on the question of the fortifications of Paris his opposition against the detached forts was formidable. His speech in 1840, on the necessity of extending the electoral suffrage, produced great sensation at the time. In the midst of his scientific and legislative labours, he found time to attend to his duties as member of the Council-General of the

Seine, to which he was elected in 1840. The period is too recent to be forgotten when he appeared before the world in a still more prominent manner, and in the decline of his useful life he was flung into the midst of the revolutionary tempest. The republicanism of Arago had nothing sanguinary or violent in it. He was named member of the Provisional Government, and Minister of War and Marine *ad interim*, and exerted himself to stem the flood which rolled on with so much violence. From the first moment he did his best to allay the passions of the multitude, but without effect. His labours during that terrible but brief period which began with the flight of the royal family and closed with the tremendous struggle of June, gave him a shock from which he never totally recovered. His double capacity as Minister of War and of Marine, and his alleged want of acquaintance with the details of those departments, form one of the most amusing passages in the memoir of "Jerome Paturot," which, I presume, is in the recollection of those who read the satirical productions of the period. Whatever may have been his qualifications for ministerial functions, his courage as a citizen was not doubted. In the midst of the horrible carnage of the days of June he marched at the head of the troops against the barricades of the 12th arrondissement, and exhausted every effort, but in vain, to stop the slaughter. His name, once so popular in that quarter, had lost all its influence; and it is said the insurgents directed their fire against him, when, advancing alone to a barricade, and waving a white flag, he implored the infuriated multitude to consent to terms of peace. That deadly struggle put an end to the political career of Arago. Broken down morally and physically, he never again assumed a prominent position; and, though he still retained his place in the National Assembly, he gave his vote in silence. His altered features, and his form once so stately, but now bowed down less by age than by sorrow, gave token of his sad disappointments.

The *coup d'état* of the 2d of December completed the destruction of all his fond illusions. Summoned as a public functionary to take the oaths to the new government, he refused, and prepared to resign the place he had occupied in the

Observatory for so many years. The government, however, made an exception in his favour, and Arago remained to his last breath Perpetual Secretary of the Academy of Sciences.

In this emergency he addressed the following noble letter to the Minister of Public Instruction; and it had the happy effect of changing the decision of the Emperor, who allowed him to retain both his offices:—

"Paris, May 9, 1852.

"Monsieur le Ministre,—The government has itself admitted that the oath prescribed by Art. 14 of the Constitution ought not to be required from the members of a purely scientific and literary body like the Institute. I cannot see why the Bureau des Longitudes, an astronomical academy in which, when a vacancy occurs, an election ensues to fill it up, is placed in another category. This simple circumstance would perhaps have sufficed to induce me to refuse the oath, but considerations of another nature, I confess, have exercised a decisive influence on my mind. Circumstances rendered me, in 1848, as member of the Provisional Government, one of the founders of the Republic. As such, and I glory in it at present, I contributed to the abolition of all political oaths. At a later period I was named by the Constituent Assembly president of the Executive Committee; my acts in this last-named situation are too well known to the public for me to have need to mention them here. You can comprehend, Monsieur le Ministre, that in presence of these reminiscences my conscience has imposed on me a resolution which perhaps the Director of the Observatory would have hesitated to come to. I had always thought that, by the terms of the law, an astronomer at the Bureau of Longitude was appointed for life, but your decision has undeceived me. I have therefore, Monsieur le Ministre, to request you to appoint a day on which I shall have to quit an establishment which I have been inhabiting now for near half a century. That establisment, thanks to the protection given to it by the Governments which have succeeded each other in France for the last 40 years,—thanks, above all, I may be allowed to say, to the kindness of the Legislative Assemblies in regard to me—has risen from its ruins and its insignificance, and can now be offered to strangers as a model. It is not without a profound sentiment of grief that I shall separate from so many fine instruments, to the construction of which I have more or less contributed; it is not without lively apprehension that I shall behold the means of research created by me passing into malevolent, or even hostile hands; but my conscience has spoken, and I am bound to obey its dictates. I am anxious that, in this circumstance, everything shall pass in the most open manner; and in consequence, I hasten to inform you, Monsieur le Ministre, that I will address to all the great academies of Europe and America—for I have long had the honour of belonging to them—a circular to intimate my removal from an establishment with which my name had been in some sort identified, and which was for me a second country. I desire it to be known everywhere, that the motives which have dictated my determination have nothing for which my children can ever blush. I owe these explanations, above all, to the first-rate *savans* who honour me with their friendship, such as Humboldt, Faraday, Brewster, Melloni, &c. I am anxious, also, that these illustrious personages shall not be uneasy concerning the great change which this determination of mine will produce in my existence. My health has, without doubt, been much impaired in the service of my country. A man cannot have passed a part of his life going from mountain-peak to mountain-peak, in the wildest districts of Spain, for the purpose of determining the precise figure of the earth; in the inhospitable regions of Africa comprised between Bougia and the capital of the Regency; in Algerine corsairs; in the prisons of Majorca, of Rosas, and Palamos—without profound traces being left behind. But I may remind my friends, that a hand without vigour can still hold a pen, and that the half-blind old man will always find near him persons anxious to note down his words. Receive, Monsieur le Ministre, the assurance of my respect. "FR. ARAGO."

"Monsieur,—In excusing yourself on May 9 on the score of ill health, for not attending with your colleagues of the

Board of Longitude to take the oath to the Prince President and to the Constitution, you had authorized me to suppose that you would not decline an obligation imposed by the Constitution on all public functionaries. Your second letter, which bears the same date, but which I received at a later hour, does not allow me to entertain that hope. Without stopping to remark on the change of language, which it is impossible not to be struck with, and on the terms—so little guarded—which I was surprised to meet with on this occasion from your pen, I considered it my duty to take the orders of the Prince before I accepted your resignation. The President of the Republic has authorized me to admit an exception in favour of a *savant* whose works have thrown lustre on France, and whose existence his government would regret to embitter. The publicity given to your letters will not change in any respect the resolution which I consider it an honour to transmit to you. Receive, Monsieur, the assurance of my distinguished consideration. "H. FORTOUL."

In his capacity as perpetual secretary to the Institute for the Physical Sciences, an office to which he succeeded on the death of Baron Fourier in 1830, it became the duty of Arago to write the Eloges of its members, both foreign and domestic. Cuvier, as the perpetual secretary for the Natural Sciences, had in this respect distinguished himself as a powerful and eloquent writer; but we venture to say that his eloges were equalled, if not surpassed, by the vigorous and eloquent biographical sketches which came from Arago's pen. The following is a list of the most important of these Eloges, with the dates at which they were read:—

1831—Volta, Foreign Associate.
1832—Dr Thomas Young, Foreign Associate.
1833—Baron Fourier.
1834—James Watt, Foreign Associate.
1837—Carnot.
1841—Condorcet.
1844—Bailly.

Of his qualifications as a legislator, the following and concluding paragraph from a sketch by Cormenin (*Les Orateurs*), published in 1842, may give a good idea:—

"Whenever Arago ascends the tribune, the Chamber, attentive and anxious, becomes still, and listens eagerly. The spectators hang over the galleries to see him. His stature is lofty, his hair is naturally curled and flowing, and his fine Southern head rises over the Assembly. In the muscular contraction of his temples there is a power of will and of thought which reveals a noble spirit. Unlike those speakers who address the house on every occasion, and who, nine times out of ten, are ignorant of what they talk about, Arago does not speak except on questions already prepared, and which combine the interest of the circumstance with the attractions of science. His speeches are therefore quite to the purpose as well as general, and appeal at once to the reason and the passions of his auditory. In this manner he soon comes to master them. The very moment he enters on his subject, he concentrates on himself the eyes and the attention of all. He takes science, as it were, between his hands; he strips it of its asperities and its technical forms, and he renders it so clear that the most ignorant are astonished, as they are charmed, at the ease with which they understand its mysteries. There is something perfectly lucid in his demonstrations. His manner is so expressive that light seems to issue from his eyes, from his lips, from his very fingers. He interweaves in his discourses the most caustic appeals to Ministers—appeals which defy all answer; the most piquant anecdotes, which seem to belong naturally to the subject, and which adorn without overloading it. When he confines himself to the narration of facts, his elocution has all the graces of simplicity. But when he is, as it were, face to face with science, he looks into its very depths, draws forth its inmost secrets, and displays all its wonders; he invests his admiration of it with the most magnificent language, his expressions become more and more ardent, his style more coloured, and his eloquence is equal to the grandeur of his subject."

Arago stood the busiest man in a busy age—the great expositor of nature's truths as they were developed by the labours of experimentalists. The idea given, Arago saw at once its entire bearing, and advanced himself by rapid strides to the elucidation of the fact. His suggestions were the guiding stars of science in France; his experiments were the foundations on which new sciences were to be built. Arago never allowed his thoughts to be involved in a theory; he accepted a theory as a means of advancing, but was ever ready to abandon it when it was found that facts favoured a contrary view. In the history of philosophy, his name will have enduring fame, not from the discoveries which he made, but from the aid which he gave to science in all its departments by his prompt and unfailing penetration. A member of nearly all the scientific societies of Europe, he was the point uniting them in a common bond. In every part of the civilized world his name was regarded with reverence, and all scientific communities felt that they had lost a friend when they heard of the death of the Astronomer of France.

The Funeral Speech of M. Flourens at the Grave of M. Arago on the day of his Funeral, which took place on the 5th October 1853.

GENTLEMEN,—Death takes us in general by surprise. The severe indisposition that M. Arago has laboured under for the last six months ought to have stripped us of all hope of ever seeing him again amongst us; but the blow which has now fallen upon us has thrown us into a state of deep consternation, as if it had never beenf oreseen. The reason is, that the void which certain people leave behind them is much greater than even our fears represented to us; and we only find out its vast extent after it has actually taken place. Yes, the mind which has become eclipsed was that powerful intelligence which the Academy cherished so much; a vast intelligence born to embrace in its grasp all the sciences, and to extend them, and in which seemed to be realized the noble vocation of our own Society, and its own motto, to discover, to invent, and make perfect.

At the very outset of his career, M. Arago had the good fortune, so desirable for a young man who desires to dream of a distinguished future, to be connected with a great work. He was appointed to go to Spain with M. Biot to complete the trigonometrical survey, a work which has given us a very precise measurement of our globe. His great capacity, and the ardent feeling with which he devoted himself to this beautiful undertaking, procured for him, on his return, the reception into the Academy. He was then scarcely twenty-three years old. In his youth he gained much affection; and the Society which so early bestowed upon him its sympathies, soon perceived with pride that he justified them all. This is not the place to enumerate all the labours of a scientific life, which was alike active, devoted, and restless. M. Arago had a decided genius for invention. He opened new roads. His discoveries on polarization, the relations of magnetism and electricity, and his magnetism of rotation, are of a high order, and have laid open to our view unknown results; nor was he less able or less fortunate in other kinds of discoveries. M. Arago often wandered out of his own proper sphere. He strove hard to raise the standard of the body that he belonged to. He was ever in search of talented young men to enlist for the Academy, to add to its reputation. All his scientific contemporaries were attached to him by the ties of the deepest gratitude. In the year 1830, M. Arago was called upon to replace M. Fourier as perpetual secretary. Since the time that he appeared at his post, the Academy seemed to become possessed of a more active life; by familiarity, which was full of charm in a superior man like him, he knew how to secure confidence and lively attachments. This gift, this great art of success, he devoted entirely to the success of that body whose organ he had become. Never did the activity of the Academy appear so powerful or so extensive. Science seemed to throw an unusual splendour, and to spread widely its brilliant light on all the productive powers of our country. Arago was gifted with a matchless penetration of mind, along with extraordinary analytical powers. The exposition of the works of others was to him a mere child's play. In his functions of secretary his thoughts were easy and rapid, with a turn for intellectual wit; and his powerful expressions invariably gained for him the marked attention of his colleagues, who always, astonished to see so many happy talents united, listened to him with a feeling of pleasure mixed with admiration. When protracted illness had deprived him of sight, the resources of his vast genius became manifest to all those who surrounded him. Works on the most difficult and complicated subjects were analysed by him in a clear, distinct, and logical manner. Thanks to his unfailing memory, all his intellectual work was done easily, and without any visible labour. The very facility of its reproduction disguised from the listener the wonder of the intellectual process.

As the historian of the Academy, M. Arago manifested in this so difficult and formidable office of high priest, as it may be called—in which capacity he had to foretell the judgment of posterity—a conscientious study, a force of investigation, a desire to be completely impartial, which procured for his eloge a very high rank. In these writings of the eloquent secretary, we find all the qualities of the great mind: a brilliant style, vigour, and enthusiasm, along with a charming good nature. As interpreter of the feelings of that Academy in which M. Arago had enjoyed a seat for nearly half a century, I was willing to speak of the man in so far as he belonged to us. He will live for ever, as one of the scientific illustrations of our country. The noble veterans of science in all parts of the civilized world, in Berlin, London, St Petersburg, and Philadelphia, will mix their grief with ours. The generation of scholars who have followed each other for the last forty years will tell to that intelligent and patriotic youth which to-day occupy their places in our brilliant schools how much beloved he was, and what power there was in the kind sympathies of that master on whose tomb they lay down at this moment the homage of their grief. Arago knew well the sweets of filial piety. The ties of his affection became extended without getting weaker. His brother and sisters were along with him under the same paternal roof; their children and his belonged to him alike. He also found a niece, whose touching and pious solicitude for him receives to-day the grateful tribute of the Academy.

On the Introduction of the Magnificent Forest Tree, the Deodar, from India into England.

The cultivation of this magnificent forest tree is about to engage the serious attention of the Government, and one or more of the royal forests are to be planted with it. Mr Jameson, Director, Botanical Gardens, North-West Provinces, India, sent home last season, by order of the Governor-General, upwards of two thousand pounds of Deodar seeds; and in order that parties now cultivating the Indian Cedar on a large scale might see the dimensions the timber attains, he also sent home four planks twenty feet in length, four feet and a half wide, and four inches thick, procured in the forests of Kooloo, in the Kohistan of the Punjaub. For years past from five to six maunds (400 to 500 lb.) of seed have been despatched annually by him to the Court of Directors, by the overland route, for distribution to public institutions and private individuals; and young plants which, ten or twelve years ago, used to sell for £5 and £6 *each*, may now be had of the nurserymen at twenty shillings *per hundred*.

Cultivation of the Deodar in England.

When, at the instance of the late Lord Auckland, at that time Governor-General of India, the Court of Directors ordered a large quantity of seed of the Deodar to be imported annually* for distribution here, a service was rendered to the

* 400 to 500 lb., which are liberally distributed to public and private gardens throughout the country. In addition to the seeds of the Deodar tree, seeds of the following coniferous trees are also sent to England from the Saharumpore Botanical Garden, being collected by the seed collectors of that noble institution in the Forests of the Himalayas, viz.—

Pinus excelsa.
... Gerardiana.
... Brunoniana.
... longifolia.
P. (Abies) Smithiana.
Picea Webbiana.
... Pindrow.
Cupressus torulosa.
Juniperus excelsa.
... religiosa.

and lastly, Pinus Royleana, a magnificent new Pine discovered last season in

United Kingdom, the extent of which cannot, as yet, be estimated. Enough, however, has been seen to assure us that we have acquired in some abundance an evergreen tree of singular beauty, perfectly hardy in these latitudes, and so unlike any other coniferous plant in its manner of growth as to add a new feature to the rich vegetation of these islands.

We now learn with great satisfaction that the East India Company has ordered a ton weight of the seed of this tree to be placed at the disposal of Government for the service of the Woods and Forests, and that the first parcel has already arrived. Should all this quantity vegetate, no fewer than 16,000,000 plants will have been acquired, and thus we may expect the hills of Great Britain to be speedily clothed with the sacred Cedar of the Brahmins; or making every allowance for deteriorated seeds, the produce to be raised must necessarily be prodigious. The charge of rearing it having been confided to four eminent nurserymen—Messrs Glendinning of Chiswick; Lawson of Edinburgh; Skirving of Liverpool; and Waterer of Knaphill—we have security for the crop being skilfully managed.*

Government will thus become possessed of a very large quantity of a fast-growing tree, the value of which cannot be over-rated, whether it is regarded as a nurse, most useful for protection, and profitable for thinning, or, according to the testimony of those who are familiar with it in India, strong and durable, as timber.

Nepaul, at an altitude of 12,000 feet. This fine Pine grows to a height of 100 feet, and its timber is close-grained, and resembles much the Deodar; and as it is met with at a great altitude on the Himalayas, it will be found to be perfectly hardy in Britain. In form, too, it is highly ornamental, and will thus prove a great acquisition. By the Director of the Botanical Gardens a large quantity of seed has been sent to the India House for distribution throughout the country. Another large supply will be forwarded shortly, and parties who have been hitherto disappointed, may procure seeds, by applying to Dr Royle at the India House.

* We have consulted one of the above gentlemen to whom part of the seeds have been confided, and we have much pleasure in stating, from his authority, that the seed that was late in reaching this country was successful, and that which was early, unsuccessful.—Ed.

We apprehend that no hardy tree yet known has the same high value as the Deodar, as a nurse. The Scotch Pine is so heavy and compact in its foliage that it keeps light off the deciduous trees which grow among it, and offers great obstruction to the free circulation of air; doing about as much harm in this way as it effects good by giving shelter from heavy gales. Its poles, too, are so bad that it must always bear a very low price in the timber market. Larch, which is a far better nurse, because its light airy foliage and pyramidal form offer no hindrance to the action of light and the free circulation of air, and whose poles usually fetch a good price, has the fault of being destitute of leaves in the early spring, and is, moreover, subject to the mysterious and incurable "rot." On the other hand, the Deodar combines the graceful form and rapid growth of the Larch, with the evergreen character of the Scotch Pine, without the faults of that species; and we have the evidence of every observer who has seen it in India, that its timber is of excellent quality. As that is a very material point, and since we have occasionally heard it suggested that because the Deodar is nearly related to the Cedar of Lebanon, its timber will probably partake of the bad quality of the latter, it seems worth while quoting the opinions of those who are personally acquainted with it. That no inference can be legitimately drawn from its supposed relationship to the Cedar of Lebanon, is sufficiently shewn by the Scotch Pine and the Pinaster. They also are nearly related; and yet the old timber of the first has great durability and strength, while the latter is at all ages worthless for any purpose except firewood. A similar but more striking contrast is offered by the Pinaster and Pinus hispanica, species surely more nearly allied than the Deodar and Cedar of Labanon. Now we have the evidence of Captain Widdrington that the latter was largely used in the Spanish navy for deck-planking, a purpose to which Pinaster timber could never be applied.

The positive testimony of Indian travellers seems conclusive as to the durability and excellence of Deodar timber. Baron Charles Von Hugel, now Austrian Minister at Florence, a good judge of such matters, saw the tree in abundance, and he calls it "the incorruptible Himalayan Cedar, the invaluable Deodar." Major Madden, than whom no one has more carefully investigated the history of Himalayan Comers on their native mountains, quotes this very expression of Von Hugel, and evidently assents to it; he even thinks it worth inquiry whether it really repels the white, and which seems to be a Himalayan notion.

Moorcroft,—and there never was a more trustworthy reporter,—in the first volume of his *Travels*, makes use of the following language: "The most valuable tree of Kashmere is, however, the Deodar, a variety of Cedar, the timber of which is extensively employed in the construction of houses, temples, and bridges." And he adds, that pieces of it had been found little decayed, although exposed to the action of water for four hundred years.

We have, moreover, the high authority of Dr Royle, who long resided in the Deodar countries, that the timber is of excellent quality, and of great strength, as well as durability. It is universally employed in the building of temples, in which none but the best materials would be employed. The mode of using it is to construct a solid framework of the timber, and then to fill in the spaces between with stones, so that the main strength of the building is made to depend upon the Deodar, rather than the masonry. Thus used, it is exposed to a trial which nothing but timber of the best quality could support. This is in complete accordance with all that we have ever heard of the quality of Deodar wood; and must be regarded as conclusive.

The only subject of doubt in our minds as to the issue of the great undertaking now described is whether the gentlemen to whom the young Deodars will be finally entrusted, after they shall have been delivered up to Government by the nurserymen who are to rear them, will know either where, or when, or how, they ought to be planted.

*Remarks on Mollusca and Shells.** By Dr Augustus Gould.

1. *On the Zoological Regions.* 2. *Specific identity of Shells.* 3. *Local aspect of Species and characteristic forms of regions.* 4. *Analogous species in co-ordinate regions.*

1. *Zoological Regions.*

The doctrine of distinct zoological regions evidently appertains to the mollusks, and is well illustrated by them. In nearly every work containing any considerable catalogue of shells, the same species will be found quoted as being found in widely-distant regions, in different oceans, and even on opposite sides of the globe. The many thousand localities carefully noted on the records of the Expedition, go to prove beyond dispute, that no such random or wide-spread distribution exists. The error has arisen from two principal causes. One is, that reliable notes of localities have not been taken. A voyage is made to the Sandwich Islands, and all the shells brought home by the vessel are said to be shells from the Sandwich Islands, though they may have been obtained at California, the Society Islands, New Zealand, and perhaps half-a-dozen other places quite as remote from each other. A sea captain purchases a collection at Calcutta or Valparaiso for his friends at home; and all the shells are marked as denizens of the port where they were purchased, though they might not have lived within thousands of miles. Purchased shells cannot be relied on for localities; for this end a shell must have been found containing the animal, or else dredged, or picked up on the shore, and labelled accordingly. There have been instances where New England shells, which had gone to the west coast of America in the way of exchange, came back again as Pacific shells.

2. *Identity of Species.*

"Shells are regarded," says Dr Gould, "as specifically identical, which, on careful comparison, are found not to be so. And this is very likely to occur where some one very remarkable peculiarity exists. Thus, a Lutraria from Lower

* United States Exploring Expedition, vol. xii.

California (*L. undulata*) has the thin, milk white, concentrically undulated valves so similar to those which characterize a shell from the coast of Carolina (*L. canaliculata*), that no one observing them separately would hesitate to pronounce them the same; but place the two side by side, and it will be seen that in one the beaks are near the posterior, and in the other near the anterior end of the shell. Equally striking resemblances and differences will be found when we compare *Mactra nasuta* and *M. braziliana*, *Lutraria ventricosa*, and *L. carinata*, the former of which are found in the Gulf of California, and their analogues in the Gulf of Mexico. So, too, we find on the catalogues *Cytherea chione* and *Natica maroccana*, Mediterranean shells, set down as found also in the Gulf of California; but a direct comparison shews them to be quite different in form and coloration, and well entitled to the distinctive appellations of *Cytherea biradiata* and *Natica Chemnitzii*. *Triton nodosum*, of the West Indies, has also been regarded as identical with a Sandwich Island species (*T. elongatum*). We need not multiply examples of this kind. But if such confusion has arisen among strongly-marked species, how much more liable is it to occur where specific differences are slight? In many genera, as in *Physa* and *Succinea*, the form, surface, and colouring, are so uniform throughout, that undoubted species are distinguished by only the slightest differences. Indeed, there are even some genera, like *Helix* and *Nanina*, *Patella* and *Lottia*, which cannot be distinguished but by an examination of the animal. When, therefore, we have before us shells from widely diverse regions, apparently identical, they should be subjected to the most careful scrutiny for structural differences. If no obvious ones are detected, we may not consider the question as settled, unless the animals have been compared; and we may go even further, and require that their internal structure, as well as external features, should be examined. The number of instances where this apparent ubiquity exists is fast diminishing, as in the cases already mentioned, in those of *Cyprea exanthema*, *cervina*, and *cervinetta*, &c. A large proportion of the shells inhabiting the eastern and western shores of the Atlantic have been regarded as identical, and many of them are really so. But the closer the comparison, the more it tends to diminish rather than increase the identical species. The same is found true in regard to other classes of animals. In fact, the doctrine of the local limitation of animals, even now, meets with so few apparent exceptions, that we admit it as an axiom in zoology, that species strongly resembling each other, derived from widely diverse localities, especially if a continent intervenes, and if no known or plausible means of communication can be assigned, *should be assumed as different, until their identity can be proved.* Much study of living specimens must be had before the apparent exceptions can be brought under the rule. Some shells have undoubtedly a very extensive range. The species of *Cypræa* are remarkable for this, and more than any other genus would lead us to conclude that oceans present no limitations. Even among them, however, new distinctions are constantly appearing. There are also some shells which may be called cosmopolite, at least they are erratic, and will be found wherever their pabulum is found. Thus, *Helix cellaria*, attaching itself to water casks, is found in most seaports in all parts of the world. *Helix similaris* is found wherever the coffee plant grows; and *Helix vitrinoides* in like manner accompanies the *Arum esculentum* or *taro*. *Bulimus octona*, or a closely allied species, is a parasite of the Banana. But exceptions of this kind confirm rather than militate against the conclusion.

3. *Local Aspect of Species, and Characteristic Form of Regions.*

There is a certain local aspect, or peculiar facies, which impresses itself upon us the more we study local collections; just as we learn by a very little observation, to distinguish men of different nations and neighbourhoods. Thus we distinguish the loose, horny, colourless structure of the northern marine species; the stony, corroded, livid New Zealanders; the polished, absolutely perfect specimens from the coral seas. Certain forms are so characteristic of certain regions, that we never expect to find them elsewhere. Thus we look for *Clausilia* in Europe and Asia; for *Achatina* in Africa;

for *Cylindrella* in the West Indies and their neighbourhood; for *Achatinella* in the Sandwich Islands; for *Partula* in the Pacific Islands, south of the equator; to the United States of America we look for *Helices* with toothed apertures; to the Philippine Islands for the ivory and beautifully painted species, &c.; and we venture to call them stragglers, if we are brought to us from any other quarter.

Dr Pickering remarks, in relation to the Feejee Islands, "It was only here, in the midst of the coral sea, where I found myself surrounded by a great variety of *Cone*, *Mitre*, *Olive*, *Cowry*, *Ovula*, *Harpa*, *Terebra*, *Cassis*, *Strombus*, *Conolix*, *Pyramidella*, *Tridacna*, *Vulsella*, *Lima*, &c., that I became fully aware of the imperfect state of this science. We missed *Patella*, *Eburna*, *Terebellum*, *Cancellaria*, *Hippopus*, *Ancillaria*, and *Marginella*. Bivalves seem to prevail less than at Tonga. *Mactra* proper was not met with. In fluviatile shells these islands are richer than the eastern ones, no doubt on account of their larger size, and the consequent greater abundance of fresh water. A fresh-water bivalve, *Cyrena*, was here met with for the first time among the islands. Among land-shells we missed *Partula*. The appearance of large *Bulimi* reminded one of the continent. The true *Helices* seem to be supplanted by *Nanina*.

4. *Analogous Species in co-ordinate Regions.*

Another point of interest, extensively elucidated by the collections of the Expedition, is the occurrence of analogous species in co-ordinate regions. It is now a received fact that the animals and plants of the northernmost zones are, for the most part, identical throughout the whole circuit; and that the species gradually diverge from each other towards the equator, on the three continents; and that after passing the equator towards the north, there is not a return to the same species, and rarely to the same genera, as we should expect if variation of forms depended mainly on difference of temperature. There is, however, a return to molluscs of a kindred character and form, and oftentimes to the same genera.

The analogies of specimens from distant regions, are much stronger when reckoned by isothermal longitude, than by isothermal latitude. In the latter case we may have analogous genera. Along our northern seas, some of the most characteristic shells are, *Buccinum*, *Tritonum*, *Fusus*, *Terebratula*, *Rimula*, &c. Around Cape Horn are shells of the same types, so closely allied that they have not yet been separated as distinct genera, though peculiar in many important respects. But this resemblance does not descend to species. In the first case, however, not only have we the same genera, but the species seem to repeat each other; so that species brought from great distances east or west are scarcely to be distinguished upon comparison. As examples in illustration, we may place against each other the following species, from Oregon, and from the Eastern States ;—

Mya præcisa.	Mya truncata.
Osteodesma bracteatum.	Osteodesma hyalina.
Cardita ventricosa.	Cardita borealis.
Cardium blandum.	Cardium Icelandicum.
Venus calcarea.	Venus mercenaria.
Alasmodonta falcata.	Alasmodonta arcuata.
Helix Vancouverensis.	Helix concava.
Helix loricata.	Helix inflecta.
Helix germana.	Helix fraterna.
Planorbis vermicularis.	Planorbis deflectus.
Planorbis opercularis.	Planorbis exacutus.
Lacuna carinata.	Lacuna vincta.
Natica Lewisii.	Natica ferox.
Trichotropis cancellata.	Trichotropis borealis.
Fusus fidicula.	Fusus turricula.
Lottia pintadina.	Lottia testudinalis, &c.

Mingled with these are others very different in type, which mark the two localities as constituting very different zoological regions. Where, for instance, have we the analogues of *Parnopœa generosa*, *Lutraria ventricosa*, *Triton oregonense*, on the one hand, and of *Mactra gigantea*, *Fusus decemcostatus* and *Icelandicus*, *Pyrula canaliculata* and *carica*, *Pandora trilineata*, &c., on the other? The same comparison holds good between the shells of the Gulf of California and the Gulf of Mexico.

From a consideration of the land-shells collected on the Pacific islands, it seems possible to draw some fair inferences as to the relations of the lands which once occupied the area of the Pacific Ocean, and whose mountain peaks evidently now indicate, or constitute, the islands with which it is now studded. By observation of the species, we think there are strong indications that some groups of islands have an intimate relation to each other, and belonged at least, to the peaks of the same mountain ranges, before they were submerged, while the indications are equally strong, that other groups had no such territorial connection.

The Samoa, Friendly, and Feejee Islands are near to each other, and seem as if they must have intimate geological relations. The Samoa and Friendly Islands give evidence of such relation, the same forms and many of the same species occurring on both groups. But, if we may draw inferences from the land-shells, these two groups are more intimately related to the Society Islands, though at a much greater distance, than to the Feejee Islands. Not a single species of land-shell found on the Feejees was collected on either side of the other groups. Several genera which are common to the other groups are wanting in the Feejees. Thus, no specimen of *Succinea* or *Partula*, genera so abundant in the Society and Samoa Islands, was found at the Feejees; and the true *Helix*, especially the pyramidal forms, so remarkable in the other groups, seemed to be replaced by large species of *Nanina*. On the other hand, large and peculiar species of *Bulimus* occur abundantly on the Feejees, while nothing of the kind occurs on any of the other islands. Indeed, judging from the land-shells, the Feejees are more nearly allied to the islands to the westward, such as the New Hebrides, than to the Friendly Islands on the east, though so much nearer. When we examine the fluviatile shells, however, we do not find the same distinction. Many of the same species of *Melania*, *Navicella*, and *Neritina*, seem to occur in all the groups, though the large coronated species of *Melania* prevail in the Feejees. There is some reason to suspect, moreover, that the fresh-water shells collected at those islands have accidentally become more or less mingled. It must also be considered that the *Navicella*, and more especially *Neritina*, is oftentimes decidedly littoral, and even marine, in its habits.

The little island of Metia, or Aurora Island, to the north-eastward of Tahiti, is one of peculiar interest. It is a coral island, which has been elevated 250 feet or more, and has no other high island anywhere near it. On it were found four small land-shells belonging to three genera, viz., *Helix pertenius*, *Helix dædalea*, *Partula pusilla*, and *Helecina trochlea*. None of these were found upon any other island. They seem to have originated there after the elevation of the island, and have a significant bearing upon the question of local and periodical creations in comparatively modern times.

As the genus *Partula* is characteristic of the groups just south of the equator, so *Achatinella* is the characteristic shell of the Sandwich Islands. Closely connected as the islands of this group are, they each have their peculiar forms of land-shells; and, as the southern islands bear evidence of greater age than the northern ones, we may infer that, within these narrow limits, we have evidence of the appearance of some species subsequent to the existence of others now living. On the island of Kauai, the oldest of the group, we have *Achatina adusta* and *pyramidata*, a form which does not appear on the other islands; the *Achatinellæ* are chiefly of the elongated glabrous form, which I have grouped under the name *Leptachatina*; the Helices are planorboid and multispiral. On Molokai, the species of *Achatinella* are large and beautiful, and peculiar in their form and colouring. On Maui, the Helices are small and glabrous, with some very curious hispid and ribbed species, with lamellæ within the aperture. On Oahu, the species of both *Helix* and *Achatinella* are similar to those on Maui. On Hawaii, *Succinea* seems to prevail in larger proportion than on the other islands, while *Achatinella*, which occurs so abundantly on all the other islands, either does not occur at all, or but very rarely.

Report of the Maritime Conference held at Brussels for devising a Uniform System of Meteorological Observations at Sea.

By carefully collating the observations on the direction of the wind, and of the currents of the ocean, from the log-books of upwards of 10,000 voyages, Lieutenant Maury, of the United States Navy, has been able to construct a series of wind and current charts, which have already proved of the highest value to navigation,—voyages have been greatly shortened, and their cost and risk much diminished. In constructing these charts, the ocean is divided into spaces of 5° of latitude and 5° of longitude, and the direction of the wind which is observed in one part of these districts is assumed to be that in which it is blowing in every other part of the district. A special chart is appropriated to each month of the year, and thus the navigator is able to see at a glance what are the prevalent winds in every part of the ocean at any time of the year, and is enabled so to shape his course as to avail himself of the favourable winds, and to avoid those which are opposed to his course. From this brief sketch of the principle upon which the wind charts have been constructed, it will be readily understood that the observations upon the direction of the currents of the ocean and their temperature, when collated in the same manner, will enable us to trace their circulation through every part of the ocean, and the causes which give rise to and perpetuate their movements; as the observations on the temperature and pressure of the atmosphere will enable us to trace the origin and course of the great atmospheric currents.

But when it is considered that even for spaces so large as 5° of latitude and 5° of longitude, the least number of observations which are required for the three great oceans amounts to the enormous number of 1,669,200, the minimum number for each square being 100; and when it is borne in mind that certain parts of the ocean are more frequently traversed by the vessels of one nation than by those of another, and some parts very rarely traversed by any, it will be evident that this admirable system, so ably begun by Lieutenant Maury, can only be carried out effectually by the co-operation of all the principal commercial nations. To carry out this system, the conference whose report is subjoined was held, and it is a subject of sincere congratulation to know that not only our own Government, but the Governments of several of the other nations who were represented at that conference, are already taking active measures for carrying into effect the recommendations which are contained in this report.

But as Lieutenant Maury very justly observes, " the importance of concert among meteorologists all over the world, and of co-operation between the observer on shore and the navigator at sea, so that any meteorological phenomenon may be traced throughout its cycle both by sea and land, is too obvious for illustration, too palpable to be made plainer by argument, and therefore the proposition for a general conference to arrange the details of such a comprehensive system of observation, addresses itself to every friend of science and lover of the useful in all countries."—(See Lieutenant Maury's *Sailing Directions*, 5th edition, p. 30.)

These sentiments are fully participated in by the most eminent meteorologists in Europe, including Quetelet, Kupffer, Kreil, Dove, Lamont, Bravais, Hansteen, our own distinguished Astronomer-Royal, and the officers in charge of the meteorological observatories in Spain, Holland, &c.; and a second conference is now proposed to effect a system of co-operation for observers on land, similar to that which in the first conference has been recommended for observers at sea. We dare not speculate on the result to be obtained by so vast a system of observations, but we cannot doubt but that they will be of highest interest to science, and of the greatest benefit to mankind; and we may congratulate ourselves on living in an era when scientific men in all nations, setting aside all petty national or selfish views, are prepared to combine their labours for the good of all—presenting a spectacle such as history cannot refer to.

REPORT.

" In pursuance of instructions issued by the Governments respectively named below, the officers whose names are hereunto annexed, assembled at Brussels for the purpose of holding a conference on the subject of establishing a uniform system of meteorological observations at sea, and of concurring in a general plan of observation on the winds and currents of the ocean, with a view to the improvement of navigation, and to the acquirement of a more correct knowledge of the laws which govern those elements.

"The meeting was convened at the instigation of the American government, consequent upon a proposition which it had made to the British government, in reply to a desire which had been conveyed to the United States, that it would join in a uniform system of meteorological observations on land, after a plan which had been prepared by Captain James, of the Royal Engineers, and submitted to the Government by Sir J. Burgoyne, Inspector-General of Fortifications.

"The papers connected with this correspondence were presented to the House of Lords on the 21st of February last,* and have been further explained in the minutes of the conference. And it is here merely necessary to observe, that some difficulties having presented themselves to the immediate execution of the plan proposed by the British government, the United States availed themselves of the opportunity afforded by this correspondence, of bringing under the notice of the British government a plan which had been submitted by Lieutenant Maury, of the United States Navy, for a more widely extended field of research than that which had been proposed, a plan which, while it would forward the object entertained by Great Britain, would, at the same time, materially contribute to the improvement of navigation and to the benefit of commerce.

"An improvement of the ordinary sea route between distant countries had long engaged the attention of commercial men, and both individuals and nations had profited by the advances which this science had made through a more correct knowledge of the prevailing winds and currents of the ocean. But experience had shewn that this science, if it did not now stand fast, was at least greatly impeded by the want of a more extended co-operation in the acquirement of those facts which were necessary to lead to a more correct knowledge of the laws which govern the circulation of the atmo-

* See Parliamentary Papers, No. 115,

sphere, and control the currents of the ocean; and that the subject could not receive ample justice, nor even such a measure of it as was commensurate with the importance of its results, until all nations should concur in one general effort for its perfection. But, could that happy event be brought about, could the observations be as extensive as desired, and receive that full discussion to which they were entitled, the navigator would learn with certainty how to count upon the winds and currents in his track, and to turn to the best advantage the experience of his predecessors.

"Meteorological observations, to a certain extent, had long been made at sea, and Lieutenant Maury had turned to useful account such as had from time to time fallen into his hands;* but these observations, although many of them good in themselves, were but isolated facts, which were deprived of much of their value from the absence of observations with which they could be compared, and, above all, from the want of a constant and uniform system of record, and from the rudeness of the instruments with which they had been made.

"The moment then appeared to him to have arrived when nations might be induced to co-operate in a general system of meteorological research. To use his own words, he was of opinion that 'the navies of all maritime nations should co-operate, and make these observations in such a manner, and with such means and implements, that the system might be uniform, and the observations made on board one public ship be readily referred to, and compared with the observations made on board all other public ships, in whatever part of the world; and, moreover, as it is desirable to enlist the voluntary co-operation of the commercial marine, as well as that of the military of all nations, in this system of research, it becomes not only proper, but politic, that the forms of the abstract log to be used, the description of the instruments to be employed, the things to be observed, with the manipulation of the instruments, and the methods and modes of observation, should be the joint work of the principal parties concerned.'

"These sentiments being concurred in by the Government

* See Sailing Directions by Maury.

of the United States, the correspondence between the governments was continued, and finally each nation was invited to send an officer to hold a conference at Brussels on a given day.

"And that the system of proposed observation and of combined action might become immediately available, and be extended to its widest possible field of operation, it was determined to adapt the standard of the observations to be made to the capabilities of the instruments now in general use in the respective naval services, but with the precaution of having all these instruments brought under the surveillance of parties duly appointed to examine them and determine their errors; as this alone would render the observations comparable with each other through the medium of their respective standards.

"The conference opened its proceedings at Brussels on the 23d of August 1853, in the residence of M. Piercot, the Minister of the Interior, to whom the thanks of the conference are especially due.

"M. Quetelet was unanimously elected president.

"Before entering upon any discussion, it was the desire of all the members of the conference that it should be clearly understood, that, in taking part in the proceedings of the meeting, they did not in any degree consider themselves as committing their respective governments to any particular course of action, having no authority whatever to pledge their country in any way to these proceedings.

"The objects of the meeting having been explained by Lieutenant Maury,* the conference expressed its thanks to that officer for the enlightened zeal and earnestness he had displayed in the important and useful work which forms the subject of the deliberations of the conference.

"In concerting a plan of uniform observation, in which all nations might be engaged, the most obvious difficulty which arose was from the variety of scales in use in different countries. It is much to be desired that this inconvenience should be removed; but it was a subject upon which the conference, after mature deliberation, determined not to re-

* See the Minutes of the Proceedings of the Conference.

commend any modification, but to leave to each nation to continue its scales and standards as heretofore, except with regard to the thermometers, which it was agreed should, in addition to the scale in use in any particular service, have that of the centigrade placed upon it, in order to accustom observers in all services to its use, with a view to its final and general adoption.

"The advantages of concert of action between the meteorologist on land and the navigator at sea were so obvious, that, looking forward to the establishment of a universal system of meteorological observation upon both elements, it was thought that the consideration of scales could, with greater propriety, be left for that or some such occasion.

"As to the instruments to be recommended, the conference determined to add as few as possible to such as were in common use in vessels of war; but, regarding accuracy of observation as of paramount importance, the conference felt it to be a matter of duty to recommend the adoption of accurate instruments, of barometers and thermometers especially that have been carefully compared with recognized standards, and have had their errors accurately determined, and that such instruments only should be used on board every man-of-war co-operating in this system, as well as on board any merchantman, as far as it may be practicable.

"The imperfection of instruments in use at sea is notorious. The barometer having hitherto been used principally as a monitor to the mariner, to warn him, by its fluctuations, of the changes in prospect, its absolute indication of pressure has been but little regarded, and makers seldom, if ever, determined the real errors of these instruments, or, if known, still more rarely ever furnished the corrections with the instruments themselves.

"That an instrument so rude and so abundant in error as is the marine barometer generally in use, should, in this age of invention and improvement, be found on board any ship, will doubtless be regarded hereafter with surprise; and it will be wondered how an instrument so important to meteorology, and so useful to navigation, should be permitted to remain so defective, that meteorologists, in their investigations concerning the laws of atmospheric pressure, are compelled in great measure to omit all reference to the observations which have been taken with them at sea. The fact will, it is believed, afford a commentary upon the marine barometers now in use, which no reasoning or explanation can render more striking.

"It was the opinion of the conference that it would not be impossible, considering the spirit of invention and improvement that is now abroad in the world, to contrive a marine barometer which might be sold at a moderate price, that would fulfil all the conditions necessary to make it a good and reliable instrument; and a resolution was passed to that effect, in order to call the attention of the public to the importance of an invention which would furnish the navigator with a marine barometer that at all times, and in all weathers at sea, would afford the means of absolute and accurate determinations.

"The conference is also of opinion that an anemometer, or an instrument that will enable the navigator to measure the force, velocity, and direction of the wind at sea, is another desideratum.

"The conference was of opinion, that the mercurial barometer was the most proper to be used at sea for meteorological purposes, and that the aneroid should not be substituted for it.

"With regard to thermometers, the conference does not hesitate to say, that observations made with those instruments, the errors of which are not known, are of little value; and it is therefore recommended, as a matter well worth the attention of co-operators in this system of research, whether some plan may not be adopted in different countries for supplying navigators, as well in merchantmen as in men-of-war, with thermometers the errors of which have been accurately determined.

"For the purposes of meteorology various adaptations of the thermometer have been recommended, such as those which refer to hygrometry and solar radiation; and, accordingly, a space will be found in the columns for temperature by thermometers with dry, wet, and coloured bulbs. With these exceptions, the only instrument, in addition to those generally used at sea, for which the conference has thought proper to recommend a column, is that for specific gravity; the cost of this instrument is too insignificant to be mentioned.

"The reasons for recommending the use at sea of the wet, the white, and black bulb thermometers are obvious; but with regard to the thermometer with a bulb the colour of sea-water, and the introduction on board ship of a regular series of observations upon the specific gravity of sea-water, it may be proper to remark that, as the whole system of ocean currents and of the circulation of sea-water depends in some degree upon the relative specific gravities of the water in various parts of the ocean, it was judged desirable to introduce columns for this element, and to recommend that observations should be carefully made with regard to it, both at and below the surface.

"With respect to the thermometer having a bulb of the colour of sea-water, it is unnecessary to say more in favour of its use on board ship than that the object is to ascertain whether or no such observations will throw any light upon the psychrometry of the sea, or upon any of the various interesting phenomena connected with the radiation from the surface of the ocean.

"In bringing to a conclusion the remarks upon instruments, the conference considered it desirable, in order the better to establish uniformity and to secure comparability among the observations, to suggest, as a measure conducive thereto, that a set of the standard instruments used by each of the co-operating Governments, together with the instructions which might be given by such Governments for their use, should be interchanged.

"The object of the conference being to secure as far as possible uniformity of record and such a disposition of the observations that they would admit of ready comparison, the annexed form of register was concerted and agreed upon. The first columns of this form will receive the data which the Government of the United States requires merchant vessels to supply, in order to entitle them to the privileges of co-operators in this system of research, and may therefore be considered as the *minimum* of what is expected of them. This condition, which it may be as well to state here, requires that at least the position of the vessel and the set of the current, the height of the barometer, the temperature of the air and water, should each be determined once a-day, the force and direction of the wind three times a-day, and the observed variation of the needle occasionally.

"Every abstract log kept by a merchant vessel should contain at least what is here recommended. Anything more would enhance its value and make it more acceptable.

"The remaining columns are intended principally for men-of-war to fill up in addition to those above mentioned, but it is believed that there are many officers in the mercantile navy also who are competent to this undertaking, and who will, it is hoped, be found willing to distinguish themselves in this joint action for the mutual benefit of the services.

"In the compilation of this form the conference has had carefully in view the customs of the service and the additional amount of attention which these duties will require, and it is believed that the labour necessary for the purpose, at least to the extentspecified in the instructions for filling up the columns, is only such as can be well performed under ordinary circumstances, and it has considered it a *minimum*, and looks with confidence to occasional enlarged contributions from zealous and intelligent labourers in the great cause of science.

"The directions for filling up the columns, and for making certain observations, it will be seen by the minutes, were limited to such only as seemed necessary to the conference to insure uniformity of observation. This subject received the benefit of much discussion before the meeting, and it was considered most advisable to confine the matter to hints, which it is hoped will be found sufficient, when embodied in the instructions which each nation will probably issue with the forms, to insure that most desirable end—uniformity.

"The conference, having brought to a close its labours with respect to the facts to be collected and the means to be employed for that purpose, has now only to express a hope that whatever observations may be made, will be turned to useful account when received, and not be suffered to lie dormant for the want of a department to discuss them; and that, should any Government, from its limited means or from the paucity of the observations transmitted, not feel itself justified in providing for their separate discussion, it is hoped that it will transfer the documents, or copies of them, to some neighbouring Power, which may be more abundantly provided, and willing to receive them.

"It is with pleasure that the conference has learned that the Government of Sweden and Norway has notified its intention of co-operating in the work, and that the King has commanded the logs kept by his Swedish subjects to be transmitted to the Royal Academy of Science at Stockholm, and also that in the Netherlands, Belgium, and Portugal, measures have been taken to establish a department for the same purpose, and that the Admiralty of Great Britain has expressed its intention of giving instructions for meteorological observations to be made throughout the Royal Navy.

"The conference has avoided the expression of any opinion as to the places or countries in which it would be desirable to establish offices for the discussion of the logs, but it is confidently hoped that, whatever may be done in this respect, there will be always a full and free interchange of materials, and a frequent and friendly intercourse between the departments; for it is evident that much of the success of the plan proposed will depend upon this interchange, and upon the frankness of the officers who in the several countries may conduct these establishments.

"Lastly, the conference feels that it would but inadequately discharge its duties, did it close this report without endeavouring to procure for these observations a consideration which would secure them from damage or loss in time of war, and invites that inviolate protection which science claims at the hands of every enlightened nation; and that, as vessels on discovery or scientific research are by consent suffered to pass unmolested in time of war, we may claim for these documents a like exemption, and hope that observers, amid the excitement of war, and perhaps enemies in other respects, may in this continue their friendly assistance, and pursue their occupation, until at length every part of the ocean shall be brought within the domain of philosophic research, and a system of investigation shall be spread as a net over its surface, and it become rich in its benefit to commerce, navigation, and science, and productive of good to mankind.

"The members of the conference are unwilling to separate without calling the attention of their respective Governments to the important and valuable assistance which it has received from the Belgian Government. That the conference has been enabled to draw its labours to so speedy and satisfactory a close is in a great measure owing to the facilities and conveniences for meeting and deliberating which have been afforded by His Majesty's Government.

"Signed at Brussels, this 8th day of September 1853.

Belgium,	QUETELET, *President.* LAHURE.
Denmark,	P. ROTHE.
France,	DELAMARCHE.
Great Britain,	F. W. BEECHY. H. JAMES.
Netherland,	JANSEN.
Norway,	IHLEN.
Portugal,	DE MATTOS CORREA.
Russia,	GORKOVENKO.
Sweden,	PETTERSSON.
United States,	MAURY."

An Essay on the China-stone and China-clays of Cornwall, with a Description of some Mechanical Improvements in the Mode of Preparation of the latter. By Mr H. M. STOKER, of St Austell, Cornwall.

The China-stone and China-clays of our county, or the disintegrated granites, have of late years assumed a no less important than interesting feature in its history; not only to the capitalist, from the great addition the discovery of their use has made to its commercial importance; to the working-classes, from the necessarily co-existent increase of employment; to the shipping, from the quantity annually exported; but also to the traveller, from the picturesque scenes, the preparation of these articles has added to the previously existing and unexampled ones offered him for contemplation in the various modes of raising and rendering available the mineral wealth for which we have been so long and so justly famed; and not only to these, but to the practical chemist as well, does it afford matter for speculation, inasmuch as the supply of the former of these articles is so limited, as to require, in the course of a very few years, some cheap and easily available substitute; whether to be supplied from this or from some other county, is a questio to be determined only by the conjoined efforts of the miner, the geologist, and the analytical chemist.

From these few remarks, any apology for the appearance of the present essay would only be out of place, especially when we take into consideration the paucity of information possessed even by such men as the jurors of the Exhibition of the past year, as proved by their indifference both to the purity and quantity of the raw material; and this is now the more to be deplored from the contrast presented to us in the degree of attention paid by those jurors who investigated the merits of this article in its manufactured state, and by the observations necessarily made on other raw material, not less than from the fact that in no work with which I am at present acquainted has the preparation or the source of this article been fully described.

These observations will be found to refer generally to those districts whence the greater amount is attainable, and from them I have reason to hope that some few general laws may be deduced, whereby, when the present source is exhausted, other localities may be found in the county for their supply.

Attention was first directed to the fact, that the disintegrated granite and clays of our county, as well as those of Devon, when fused or burned, could be rendered available to the potter, in 1768, by the late Mr Cookworthy of Plymouth, who extensively exported them to the potteries of Staffordshire for that purpose from Devon; subsequently to which, large beds of a like description of clays were found in the parish of St Stephen's: and it having been ascertained that the decomposing granite, from which such beds are formed, was capable, when fused, of forming a suitable glaze for the articles made of the clay, a large trade was at once opened, which has continued progressively to increase till the present time.

The disintegrated granite, under the name of China-stone, from the use to which it was applied, was exported at a later period than the China-clay or kaolin,—this article of commerce not having been introduced till the year 1802, when it was first raised from a bed of great purity, containing no iron or manganese, but merely felspar, silica, and mica, in varying proportions. And this is at present the only source from which it can be obtained of a sufficient degree of purity for ordinary purposes; though, from its price, and the efforts that have been made by chemists, both here and in the potteries, to gain a substitute for it, it is very doubtful whether it will long continue so; more especially if the distance we are placed from Stafford be taken into consideration.

Most of the granites from which the China-stone was formed, differ from ordinary granite only in the existence in the latter of plates of talc, hornblende, or diallage, the presence of either of which renders the China-stone in which they are found, though but in small proportions, of not even the slightest use, from the black or brown-coloured slag of silicate of iron or manganese found on fusion. Some variation, too, may be found in the amount of each of the ingredients which I have named, but this affects neither the clay formed on a continuation of the disintegrating process, nor is it supposed to exert any influence on the glazing properties of the stone.

The places in which a search for this article would be instituted with the greatest probability of success, is in the proximity of fissured granite rocks, containing, or supposed to have contained, softened stone; or in hills with rounded heavy summits, the beds of which are placed horizontally, and felspar (or feldspar) forming its predominating ingredient.

The bed from which it is obtained is about three-fourths of a mile in extent, on the contiguous borders of the parishes of St Dennis and St Stephens, occupying almost the centre of the central granite district of the county, and is surrounded by other primary rocks of igneous origin, which, as they stretch towards the coast on either side, merge into beds of killas or clay-slate. On the eastern and northern boundaries, the granite is more irregular and abrupt in character than on the other sides, is more porphyritic, and contains a much larger proportion of felspar, in large white or red opaque, cubic, or rhomboidal crystals; while on the south it is separated from the neighbouring granite by a large elvan dyke. And it is worthy of notice, that, while on one side of this you may find China-stone perfectly pure, on the other, only from one to two feet distant, the stone is rendered useless by the presence of small plates of talc imbedded in dense gray granite, which also forms a portion of the eastern boundary.

Any one who has carefully studied the porphyry dykes, or the general nature of the primary rocks of our county, cannot but have noticed the difference in the temperature at which some of them have been upheaved, compared to that of others; for while some of our granites are composed of substances which have in their crystals a certain amount of water that has not been lost, others have no trace of it, their felspar having become an amorphous-looking powder (kaolin); and others presenting the same waxy edge on fracture that is noticed in porcelain, particularly the elvan dykes: and from this it has been conjectured, though to me it appears doubtful, that as the melting point of other minerals was considerably below that of these rocks, at the time of the extraordinary convulsion to which our county has been subjected, the China-stone was by this means freed from iron, &c.; and that, on its having reached the surface, the water by which it was surrounded at once caused the crystals of felspar to split, lose their outline and character, and become easily acted on by the solvent power of rain-water, which, by depriving it of a portion of its potash, leaves the crystals of quartz or silicic acid and plates of mica, glistening with a silvery hue, imbedded in a mass of silicate of potash and alumina; which, from the loss of crystallization, cannot be termed felspar, nor is it kaolin. for it has not been subjected sufficiently long to the causes which lead to its formation.

Many have thought, and do still suppose, that the clay is gradually forming into granite, and confidently assert that the whole of the middle granite tract was undoubtedly formed from clay beds; the geologist, I need scarcely add, will be able to estimate this at its proper worth: others also add, that this mass has been thrown up in the water, which at first covered it and fell back on itself, which they assert accounts for the flattened outline the tops of the hills of this district present.

The chief causes which I believe to have led to its disintegration, and not only to the formation of China-stone, or China-clay, but to that of all the land at present in cultivation or capable of being cultivated, are — 1*st*, external physical agents, proved by the fact that China-stone is very seldom found at a depth of more than from 20 to 30 feet from the surface; the influence of the seasons; the changes from hot to cold on a body composed of crystals possessing such different expansive powers as those of felspar and quartz; and the solvent power of rain-water: while, as chemical agents, we have, 2*dly*, the influence of the excess of carbonic acid in the air, as well as that from the interior of the earth, of the influence of which we have abundant proof in the excellent crops obtainable near lavas, or wherever this gas can gain access to the compound silicates of which the greatest portion of the earth's crust consists; and by the influence of respiration in rooms provided with windows, which may have been exposed for a long period to its application.

At present, while there is a great demand for the article, the spot from whence China-stone is procured presents the appearance of a large rabbit burrow, as there are no less than nine sets for the district, the proprietor of each of which has his portion of the hill covered with the mouths of pits, around which are stationed a number of men with their waggons, who, after the China-stone has been raised by quarrying and the employment of powder, carry it to one of the nearest ports to be shipped for the potteries of Staffordshire and Worcestershire. These ports are distant seven or nine miles from the quarries, entailing in this transport a considerable amount of land carriage, and a consequent increase in the price, which of late years has been raised from 12s. to 20s. free on board, at Par, Pentewan, or Charlestown; still the demand has by no means diminished, and the proprietors of these sets have been obliged to fix a certain limit to their annual supply of 18,000 tons, which rate of consumption will have effected the removal of all the China-stone in these beds in rather less than fifty years.

The number of people employed in its preparation are comparatively few, as the operation of blasting requires but two or three persons in each pit; and in loading the waggons the parties employed as carriers are but too eager to fill in order to gain a load. The before-mentioned reasons render the question of supply an important one, and one well worthy the attention of the land-owner as to future resources, and the influence the discovery of any large bed of good stone would exert on his pocket; though, while the present sets of the China-stone Company of Cornwall hold out, they not only can but will maintain a monopoly.

China-stone, in its present state, consists of a mixture of quartz, felspar, and mica, blended so as to form a homogeneous mass which very much resembles granite, though its texture is not so compact; the quartz exists in small bluish-white and transparent crystals, the edges of which, by the process of disintegration, are rendered more or less indistinct, and they have become more transparent than when in the form of granite. These crystals are imbedded in a mixture of white felspar which has lost a portion of its potash, and small opaque scales of mica having a lustrous silvery aspect and very thin: the granite from which it has been formed is of the simplest kind, the more common forms containing, in addition to the mica, quartz and felspar, which may be either red or gray, crystals and scales of hornblende, diallage, or talc, with a more or less appreciable amount of iron, indicated by the black spots formed on fusion or calcination; and as the chemical composition of this article, when pure, should indicate an absence of these deteriorating qualities, until some cheap mode of separating these constituents from the otherwise vitrifiable granites of our county be found, the China-stone at present in use must retain its pre-eminence, consisting as it does of a pure double silicate of potash and alumina, which, when fused, forms a pearl-white translucent mass, firm and resonant, consisting of an opaque body of nearly perfectly formed kaolin, surrounded by and diffused through the glaze of silicic acid, to which its transparency is due: and not only does the foregoing deteriorating substances render the article useless, but should there be a very great excess of quartz crystals or silica the article will not, from the formation of single silicates, be capable of fusion at any temperature; though this fault may be remedied by the addition of either potash or soda, to which the vitrifaction not only of this, but of the various kinds of glass, is also due; felspar, according to Liebig, containing 17·75 per cent. of potash.

China-stone is used in the potteries for a number of purposes, the most important of which are, 1*st*,—in the formation of clay bodies to form biscuit ware; 2*dly*,—to strengthen clays rendered poor by the absence of potash; and, 3*dly*,—in the preparation or construction of glazes, for the calcined biscuit ware, when mixed with other ingredients.

The manufactured China-stone and China-clay is termed "pottery," of which there are several varieties, each containing different proportions, of China-stone, clay, and other articles. In the porcelain series there is said to be but 3 per cent. of potash, but this I imagine, from the transparency and purity of the body, to be inaccurate: the Chinese used to employ the ashes of ferns, which, from the amount of carbonate of potash they contain, gave to it that richness and blending of the body with the glaze for which it has been long remarkable: bone ash was also used, both by the Chinese and French, and is now employed by our potters in considerable quantity, for the sake of the phosphate of lime it contains, which, during the process of fusion, adds considerably to the transparency of the ware without rendering the glaze liable to craze or peel off, as would be the case were lime alone employed; in fact at times, during a single firing, more than £5000 worth of pottery is rendered useless by the admixture of this earth, the surface of the services becoming covered with a congeries of cracks and fissures; hence great care is necessary to prevent its addition.

The terms employed to designate the kinds of calcined and fused wares, are:—Pipe-clay, the least used and least important; Queen's ware; Terra Cotta; Basalts; and Porcelain biscuit; the whole of which were introduced by Wedgewood, to whose persevering, accurate, and scientific research, we are indebted for the position our pottery now holds; and it should not be forgotten that the rapid strides by which we have gained it, and the discoveries that have of later years been made in this art, have been wholly derived from a good practical acquaintance with chemical analysis, the importance of which cannot be too strongly urged, on both the potter and the producer of the raw material. The other and more common wares are, porcelain; pottery, an inferior kind of porcelain; and earthenware; to the description of which I shall for the present confine my attention, that of the before mentioned wares, as well as of Parian, biscuit china, &c., belonging more strictly to the province of the potter than to that of the writer of the present Essay; though, from the history of the experiments to which their existence is due, the subject will be found fraught with interest to the chemist and geologist.

Until a very late period pottery manufacture was comparatively unknown in England; in the eighteenth century we were indebted entirely to the Chinese for our best, and to the continental potteries for our commoner wares; a century has but elapsed, and to the credit of the industrious, the persevering, the indefatigably speculating, Englishman, be it added, that from pole to pole, under any portion of the globe's equator, wherever the traveller may roam in search of adventure, no less than through the length and breadth of his happy little island home, he will find, in his cup, his plate, or his dish, a never dying testimonial to the enterprising character of the Englishman.

In porcelain or china and the coarser variety termed pottery, the ingredients are so combined as to act chemically on each other, the decomposed felspar consisting of a fusible glass of silicate of alumina and potash, more opaque than that formed by the fused silex in which it is disseminated; and when the body is formed of China-clay, infusible at the highest temperature, in the process of vitrifaction, it is so acted on, as to form a substance uniformly opaque, having a vitreous, waxy fracture, and when coloured by some metallic base is termed stoneware.

There are two kinds of china or porcelain; the one termed the hard china was formerly imported from France, though, of late years, it has been altogether superseded by the second variety, or soft china. The body of hard china may be conveniently formed by a mixture of ingredients in the following proportions:—

Kaolin, or China-clay .	70 parts
Felspar . . .	14 ...
Sand	12 ...
Selenite . . .	4 ...

which calcined, forms the biscuit: this, after being dipped in a mixture of potash and felspar, is again heated, when vitrifaction ensues, the article possessing a homogeneous translucent structure, and not a mere glaze or coat as found on the common earthenware. In making soft china the English potters fully vitrify the ware by the first application of heat, the shape of the article being kept by ground flint, removable with ease after it is taken from the oven, and the glaze being subsequently applied is vitrified at a lower temperature than that used in the formation of the biscuit of soft china, the ingredients used to form which, are,—

Bone	46 parts
Kaolin	31 ...
China-stone . . .	23 ...

In making the glaze, a frit is first formed, which renders the glaze more easily applicable to the surface of the biscuit, by calcining a mixture similar to the following:—

China-stone	25 parts
Soda	6 ...
Borax	3 ...
Nitre	1 ...

Of this frit, when ground, 26 parts are taken, and added to or mixed with—

26 of ground China-stone,
31 ... white-lead,
7 ... flint,
7 ... carbonate of lime, &c.,
3 ... oxide of tin,

in which the biscuit is dipped prior to the last application of heat. The colours to be laid on the ware are applied and burnt in prior to the formation of the glaze, an article often requiring a separate burning for each different colour, thus, especially in gilded articles, entailing an additional amount of cost and labour.

The China-stone increases the strength and sonorosity of the article, while the ground flint gives whiteness and density to the base of plastic clay: earths are by themselves infusible, but on the addition of silex or silica, another name for quartz, we form a silicate, to which, if we add a third of earth, with an alkaline base, we form a body vitrifiable and uniformly translucent.

As it may not be uninteresting to my readers, I shall briefly attempt to describe the mode in which the China-stone and China-clay are treated, prior to their being turned, twisted, and flattened, to form the numberless articles in which they greet the eye.

The China-stone is ground to a fine powder by means of a number of stones which are kept rotating on the bottom of a paved vat, when it, as well as the clay and ground flint, are mixed with a certain quantity of water, by a process termed "bluging," till of the consistence of cream, when it is passed in a state of slop or slip through a series of cambric or lawn sieves kept rapidly revolving by a water-wheel, each pint of clay slip weighing twenty-four ounces, while that of the flint or China-stone weighs thirty-two ounces; it is then passed through a very fine silk sieve, after which these ingredients are mixed together in variable proportions in a large vat or tub, and, as soon as the mixture has attained its requisite consistence, the water is driven off by evaporation, which causing the slip to contain in its interstices an innumerable quantity of air globules, renders it necessary that it should be submitted to the process of kneading or beating, after which it was formerly thought necessary, though now abandoned, that this mass should lie fallow for three or four months, when it is considered to be fit for the lathe.

The proportions of the ingredients used in the different kinds of earthenware are as follow :—

In cream colour or painted ware,—Dorsetshire clay, 56 parts; kaolin or China-clay, 27; flint, 14; and China-stone, 3 parts.

In brown ware,—red clay, 83; Dorset clay, 13; flint, 2; and manganese, 2 parts.

In drab ware,—Cane marl, 32; Dorset clay, 22; China-stone, 45; and nickel, 1 part.

In jasper,—barytes, 32; kaolin, 15; Dorset clay, 15; stone, 33; and of lead, 3 parts.

The glazes commonly used for the cream-coloured ware consists of varying proportions of white lead and China-stone, or, as these may craze, a frit of the following materials is often employed:—

Of China-stone, 30; flint, 16; red lead, 25; soda, 12; and borax, 17 parts; 26 parts of this are then mixed with 15 of China-stone, 10 of flint glass, 9 of flint, and 40 of white lead; which constitutes the fritted glaze.

The composition of most of the bodies and clays now used is a secret confined to the walls of the mixing room, so that it is extremely difficult to ascertain, with any degree of accuracy, the influence of an excess of ingredients; thereby entailing a co-existent difficulty on the part of the producer, in his endeavour to form or prepare a substitute for these articles.

The China-clay or kaolin of Cornwall was first brought into notice at a very late period, though the material itself has been long used; in fact, not only were the Chinese well acquainted with it, both in a raw and manufactured state, from the most remote ages, but it is also probable, from the interesting evidences lately brought to light, through the industrious exertions of Mr Layard, and from other sources, that the Egyptians knew somewhat of its uses.

When obtained by Mr Cookworthy, in 1768, from the Lescrowse and Trethose clay works, in the parish of St Stephens, a large supply was at once demanded for the Staffordshire potteries, which has gradually increased till the present time. The average annual export of late years, which I have been enabled to offer my readers through the kindness of the most influential shipping agents in the neighbourhood, is as follows :—

At Charleston .	40,000 tons	of China-clay.
... Par . .	10,000 ...	...
... Pentewan .	18,000 ...	...
... other harbours .	12,000 ...	...

Forming a total of 80,000 tons.

From the little attention paid to former exports of this article, I have been unable to form an accurate estimation of them, though some idea of the increase may be gleaned from the following estimates of the value of the exports of the manufactured article, to the various countries with which England has any commercial relations :—

Shipped from	Stafford in	1835 .	£280,000
...	...	1837 .	560,000
...	...	1841 .	600,759
...	...	1851 .	1,210,000

while adding to this the exports from Derby, Worcester, and other potteries, will give a total of £2,150,000 shipped during the past year ; in addition to which, of late years, a considerable amount of crude kaolin has been exported to every pottery on the continent, and also to those of our inquiring American brethren, while a small portion has been used for bleaching.

(*To be continued.*)

On the Analysis of Euclase. By J. W. MALLET, Esq., Ph. D.

Euclase, from its transparency, delicate shades of colour, and perfect crystallization, is one of the most beautiful mineral species with which we are acquainted; and since it is at the same time a mineral of great rarity, good specimens of it form some of the most highly prized ornaments of mineralogical collections.

Such of the characters of the mineral as can be examined without injury to the specimens, have been pretty accurately studied, especially the complex crystalline forms under which it occurs, which have been described at length by Haüy, Weiss, Phillips, and Levy. Our knowledge of its chemical composition, however, the investigation of which involves the destruction of the specimens operated on, depends upon a single analysis by Berzelius, as the number given by Vauquelin, the only other chemist who has examined the substance, are almost valueless, presenting a loss of about 30 per cent.

Though from the high authority of Berzelius as an analyst, any other investigation could scarcely be expected to yield results of much novelty, or differing materially from those he has given, yet a second analysis possesses some interest, even if merely confirmatory of his. The results of one which I have recently made, I wish, therefore, to bring under the notice of the Society.

The material employed for this analysis, consisted of four fragments of crystals, weighing together about 20 grains. Though this is rather a smaller quantity than is usually taken for a mineral analysis, it was in the present case quite enough, as the constituents to be determined were but few, and alumina and glucina form a large proportion of the whole. These fragments were perfectly clear and transparent, three of them of a beautiful pale mountain-green, and one of a very light tinge of blue. They presented both natural crystal planes and faces of cleavage, and amongst the former were several adapted to the use of the reflecting goniometer. The mean results of some angular measurements over the obtuse lateral edges of four distinct vertical prisms were, 115° 6′, 127° 51′, 140° 44′, and 149° 32′, all of which agree nearly with numbers given by Phillips. The only cleavage I observed was that parallel to the terminal plane, replacing the acute lateral edge of the vertical prism, which is mentioned in mineralogical systems as the only cleavage easily obtained.

The specific gravity of these fragments was 3·036. They were reduced to fine powder, and fused with the mixed carbonates of potash and soda, and the analysis was then conducted according to the usual routine for silicates. The alumina and glucina were separated according to the old method by carbonate of ammonia, as from previous experiments I found the use of caustic potash, which has been more recently proposed for this purpose, both difficult and uncertain. The analysis gave the following constituents per cent. :—

		Atoms.
Silica	44·18	950
Alumina	31·87	620
Glucina	21·43	564
Peroxide of iron	1·31	016
Peroxide of tin	·35	
	99·14	

These numbers agree very fairly with those of Berzelius, and dividing by the atomic weights of the several constituents, give their equivalent proportions as in the second column. These are very nearly in the ratio :—

$$Si\,O_3 : Al_2\,O_3 : G_2\,O_3 = 3 : 2 : 2.$$

And hence we have the formula :—

$$2\,(Al_2\,O_3\,Si\,O_3) + G_2\,O_3\,Si\,O_3.$$

Or if the two earths, alumina and glucina, be isomorphous :—

$$4\,(Al_2\,O_3 + G_2\,O_3)\;3\;Si\,O_3.$$

Scacchi, taking glucina as a protoxide, suggests an analogy between euclase and epidote, but if the corrected atomic weight of this earth be used, the formulæ of these two minerals differ widely.* If, on the other hand, alumina and glucina be isomorphous, the composition of euclase coincides with that of andalusite.

$$4\ Al_2\ O_3\ 3\ Si\ O_3.$$

part of the alumina being replaced by glucina. An important objection to the idea of any real connection between these minerals, however, arises from the fact, that they occur in different crystalline systems, andalusite belonging to the right prismatic, while euclase is in the oblique prismatic system.

There was one minor point in connection with Berzelius's analysis which it was interesting to examine with special care, namely, the occurrence or not of a small quantity of tin in euclase, and I, therefore, took particular pains in testing all the reagents for this metal before using them, and made a separate blowpipe experiment on the mineral itself, with the object of reducing the tin directly. Even by the latter method there was no difficulty in distinctly ascertaining its presence, and there can, therefore, be no doubt of its really existing in the pure mineral.

The occurrence of traces of this metal in other silicates, as beryl, epidote, and a magnesian garnet, meteoric stones, and in several ores of titanium and tantalum, has been remarked by different analysts, especially by Berzelius, and is certainly a very curious fact, when we consider the extremely small number of minerals in which tin forms a leading constituent, and the improbability of such minute quantities being essential to the composition of the species in which they occur.—(*Journal of the Geological Society of Dublin*, vol. v. part iii., 1853, p. 206.)

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* The angles of crystals of the two species also differ considerably.

On the Anatomy and Physiology of Cordylophora; a contribution to our knowledge of the Tubularian Zoophytes. By GEORGE JAMES ALLMAN, M.D., M.R.I.A., Professor of Botany in the University of Dublin, &c.

The author, after pointing out the necessity of giving greater definiteness to the terminology employed in the description of the true zoophytes, proceeds to the anatomical details of *Cordylophora*, a genus of *Tubulariadæ*. He demonstrates that *Cordylophora* is essentially composed in all its parts of two distinct membranes inclosing a cavity, a structure which is common to all the *Hydroida*. For greater precision in description, he finds it necessary to give to these membranes special names, and he therefore employs for the external the name of *ectoderm*, and for the internal that of *endoderm*. Each of these membranes retains its primitive cellular structure. In the ectoderm *thread-cells* are produced in great abundance; these are formed in the interior of the ectodermal cells by a process of endogenous cell-formation, and are afterwards set free by the rupture of the mother-cell. The thread-cells in a quiescent state are minute ovoid capsules, but under the influence of irritation, an internal sac is protruded by a process of evagination; the surface of the evaginated sac is furnished with a circle of curved spicula, and from its free extremity a delicate and long filament is emitted. The thread-cells of *Cordylophora* thus closely resemble the "hastigerous organs" of *Hydra*. The polypary is a simple unorganized secretion deposited in layers from the ectoderm. In the endoderm the author points out a distinct and well-developed glandular structure composed of true secreting cells, which are themselves produced in the interior of mother-cells, and elaborate a brown granular secretion which he assumes as representing the biliary secretion of the higher animals. He describes, as a system of special muscles, certain longitudinal fibres, which may be distinctly seen in close connection with the inner surface of the ectoderm. The tentacula are shewn to be continuous tubes communicating with the cavity of the stomach, and thus possess the same essential structure as those of *Hydra;* they are formed of a direct continuation of the ectoderm of the polype, lined by a similar continuation of the endoderm. The appearance of transverse septa at regular intervals, which is so very striking in these tentacula, must not be attributed to the existence of true septa. It is due to a peculiar condition of the endodermal layer, but the author has not been able to give a satisfactory explanation of it. Through the whole of the canal which pervades the axis of the stems and branches, a constant though a regular rotatory movement is kept up in the contained fluid; this movement is not due to the propulsive action of vibratile cilia, and is explained by the author as the effect of the active processes going on in the secreting cells of the endoderm, processes which can scarcely be imagined to take place without causing *local* alterations in the chemical constitution of the surrounding fluid, and a consequent disturbance in its stability.

The reproductive system of *Cordylophora* consists of ovoid capsules situated on the ultimate branches at some distance behind the polypes; some of these capsules contain *ova,* others *spermatozoa;* they are plainly homologous with the ovigerous sacs of the marine *Tubulariadæ;* they present a very evident, though disguised medusoid structure, having a hollow cylindrical body, whose cavity is continuous with that of the polype-stem, projecting into them below, and representing the proboscidiform stomach of a Medusa, while a system of branched tubes which communicate at their origin with the cavity of the hollow organ, must be viewed as the homologues of the radiating gastro-vascular canals, and the proper walls of the capsule will then represent the disc. From comparative observations made on other genera of *Hydroida,* the author maintains the presence of a true medusoid structure in the fixed ovigerous vesicles of all the genera he has examined, and he arrives at the generalization, that for the production of true ova in the hydroid zoophytes, a particular form of zooid is necessary, in which the ordinary polype-structure becomes modified, and presents, instead, a more or less obvious medusoid conformation, *Hydra* being at present the only genus which appears to offer an exception to this law, though the author believes that the exception is only apparent, and that further observations will enable us to refer the reproductive organization of this zoophite to the same type with that of *Cordylophora* and the marine *Hydroida*. The author has satisfied himself that the ova-like bodies contained in the capsules of *Cordylophora* are true *ova*, and not *gemmæ;* he has demonstrated in them a distinct germinal vesicle, and has witnessed the phenomenon of yelk-cleavage; and the paper details the development of the embryo to the period of its escape from the capsule in the form of a free-swimming ciliated animacule, and traces its subsequent progress into the condition of the adult zoophyte.—(*Proceedings of the Royal Society, London,* 1853).

On the Elasticity of Stone and Crystalline Bodies.

By E. Hodgkinson, Esq.*

It is generally assumed by writers on the strength of materials, that the elasticity of bodies is perfect, so long as the material is not strained beyond a certain degree. But from the experiments I made several years ago, at the instance of the British Association, on the strength of Hot and Cold Blast-iron (vol. vi.), I was led to conclude that the assumption was very incorrect, as applied to cast-iron at least; and further experiments rendered it probable that it was only an approximation in any. Among the bodies of most value in the arts, cast-iron holds an important place; and I found that bars of that metal, when bent with forces, however small, never regained their first form, after the force was removed; and this defect of its elasticity took place whether the cast-iron was strained by tension, compression, or transverse flexure. I subsequently found that in the first two strains (by tension and compression), the straining force might be well represented by a function composed of the first and second powers of the change of length produced,—thus,

$$w = ae - be^2$$
$$w = a'c - b'c^2$$

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* Read before the Meeting of the British Association for the Advancement of Science at Hull.

where w is the weight applied, e the extension, c the compression, and a, a', b, b' constant quantities. If the elasticity were perfect, the part depending on the second power must be neglected. The necessity of a change in the fundamental assumption for calculating the strength of materials may be inferred from the fact, that in computing the breaking weight by *tension*, from experiments on *transverse* flexure and fracture, we obtain the strength of cast-iron three times as great as from numerous experiments I have found it to be. The formulæ of Tredgold give this erroneous result, and those of Navier are in accordance with them.

Stone.—To obtain the elasticity of stone, I had masses of soft stone, obtained from various places, sawn up into broad thin slabs, 7 feet long, and about 1 inch thick. They were rubbed smooth, and rendered perfectly dry in a stove, and were bent transversely in their least direction by forces acting horizontally. The slabs, during the experiments, were placed with their broad side vertical, and had their ends supported, 6 feet 6 inches asunder, by friction rollers, acting horizontally and vertically. It resulted from the experiments, that the defects of elasticity were nearly as the square of the weight laid on, or, consequently, as the square of the deflexion nearly, as in cast-iron. The ribs never regained their first form after the weight was removed, however small that weight had been. From other ribs of stone, obtained from various localities, and broke transversely by weights, acting vertically, and increased to the time of fracture, the ratio of the deflexion to the weights applied were found in various experiments to be nearly as below:—

·02	·01	·02	·018	·02	·027
·035	·012	·022	·023	0·22	·032
·05	·0125	·033	·024	·024	·035
·07	·014	·036	·027	·025	·038
·09	·015			·026	
·11	·016				

The ratio represented by the numbers in each vertical column, are those in each separate rib of stone; and they would have been equal if the elasticity had continued perfect, but they were increasing where the weights were increased in every instance. The change shewn by these experiments to be necessary would increase considerably the mathematical difficulties of the subject; and they would be greater still, if the change of bulk and lateral dimensions in the bodies strained were included, according to the conclusions of Poisson, or the experiments of Wertheim, which are at variance with each other. But these changes are so small in the bodies I am contemplating, that they may be neglected for all practical purposes. Thus, from my experiments, the utmost extension of a bar of cast-iron, 50 feet long, is about 1 inch, or $\frac{1}{600}$th of the length, and therefore the change of lateral dimensions of the bar being only a fraction of this $\frac{1}{600}$th, according to either Poisson or Wertheim, it is too small to need including. The experiments in which I deduced the utmost extension of cast-iron, are given in the "Report of the Commissioners on the Strength of Iron for Railway Purposes." If the body strained were wrought-iron, brass, or others of a very ductile nature, the change of lateral dimensions might, in extreme cases, be included. I beg to mention, with great deference, that the profound work of Lamé, lately published, on "The Mathematical Theory of Elasticity," in which the elasticity is considered as perfect only, does not appear to apply to such bodies as I have here treated of.—(*Athenæum*, No. 1353.)

The Classification and Nomenclature of the Palæozoic Rocks of Great Britain. By Professor SEDGWICK.*

The Professor stated that the fossiliferous rocks formed in reality only one great system, representing the whole succession of events from the first appearance of organic life to the present day. But as it was convenient to divide history into chapters, so the strata had been divided into three principal series,—the Palæozoic or Primary, the Secondary, and the Tertiary, each characterized by many families, genera, and species of peculiar fossils. The Palæozoic strata might be again divided into an upper, middle, and lower series: the

* Read before the Meeting of the British Association for the Advancement of Science at Hull.

first including the Permian and Carboniferous systems; the second, the Devonian or Old Red Sandstone; and the third, the Silurian and Cambrian systems. These rocks were characterized generally by the entire absence of Mammalia, and even of reptiles in their lower division; and by the presence of peculiar groups of shells (*Orthocerata* and *Goniatites*), crustaceans (*Trilobites*), and corals (*e. g. Graptolites*). Very few specific forms ranged from one division of this system to another; but they had great general resemblance. A few corals ranged from the Bala limestone to the Devonian, and one (*Favorites Gothlandia*) even to the lower beds of carboniferous limestone; *Terebratula reticularis* was found in the Silurian and Devonian; and *Leptaena depressa* from the Bala limestone to the Carboniferous. Prof. Sedgwick then called attention to the grounds for separating the Cambrian and Silurian systems, which he said he had always maintained to be distinct. He had commenced his observations in the Cumberland Hills, of which a section was exhibited, shewing the following successions of rocks:—1. Skiddaw, slate, usually without fossils, but containing *graptolites* in one locality; 2. Coniston limestone, abounding in fossils; 3. Coniston flagstone and grit. The order of succession of the beds above these was difficult of determination in the Lake district. He had next investigated the structure of North Wales, between the Menai and the Berwyns, and had established the existence of a great system of rocks comparable to those of the Lake district, and had given to them the name of the Cambrian system. Meanwhile, Sir R. Murchison had discovered in "Siluria" tracts exhibiting the whole upper series, equivalent to the beds above the Coniston grit. And having made good sections of the strata in ascending series, from the Llandelio flags to the Old Red Sandstone, and given names to these rocks which were now generally adopted, this country had become the type to which all others were referred for comparison, because in it the order of succession was clearly made out. It then became a question what was the boundary line between the Cambrian and Silurian systems? Sir R. Murchison had made the Llandeilo flags the base of his system, and considered the whole country westward of it to be Cambrian.

It proved, however, that the rocks to the west of the Llandeilo valley were newer, and not older than the flags; that in fact the Llandeilo flags were not above the Cambrian system, but an integral part of it. But, instead of adding the narrow belt of country occupied by these flags to the Cambrian system, Sir R. Murchison had wished to convert the whole breadth of the Cambrian region into Silurian. Prof. Sedgwick then referred to the section of the Malvern strata, as determined by Prof. Phillips; he contended that the Caradoc sandstone and conglomerate of this section belonged in reality to the Wenlock series, and proposed for it the name of "May-hill sandstone." The underlying black shales and "Hollybush sandstone," of Prof. Phillips he regarded as the true Caradoc sandstone, belonging to the Cambrian system. Prof. Sedgwick further endeavoured to shew, by sections and lists of fossils, that the Silurian May-hill sandstone existed in a distinct form in the typical district of the Caradoc sandstone. With this correction the Cambrian system would include the lower Silurian of Sir R. Murchison. The distinctness of the Cambrian or Lower Silurian from the Upper Silurian was admitted on fossil evidence; Mr Barrande had found only 6 per cent. of fossils common to the two systems in Bohemia, and Mr Hall only 5 per cent. in America. In Westmoreland the per-centage was only $3\frac{1}{2}$. Of 324 species in the Cambridge Museum, not 15 per cent. were common to the two systems, including all the doubtful cases, and the real number was probably not above 5 per cent. Professor Sedgwick then read a letter from Professor Rogers in America, expressing his approval of this nomenclature, and his conviction that it would be eventually be adopted; he also entered upon an explanation of the manner in which his various papers on this subject had been published in the *Journal of the Geological Society*, as it had been supposed that he himself had abandoned the term *Cambrian* at one time, whereas the alteration had been made in his paper by a former President (Mr Warburton) of the Society, without his knowledge.

Mr Hopkins, late President of the Geological Society, explained some of the circumstances referred to by Professor Sedgwick, and expressed a strong conviction that the Professor would succeed in establishing his nomenclature. Setting aside all personal claims, and looking solely at the merits of the case, he believed that the proportion of distinct species in the Cambrian and Silurian systems would prove to be as great as in other parallel cases.

Professor Phillips stated, that it was more than thirty years since he first met Professor Sedgwick on one of his geological excursions; and after so many years of labour, he was gratified to see that he had obtained a form of sound classification of the oldest fossiliferous rocks of the British Isles. He believed that if Sir R. Murchison were present he would put aside all points of difference, and also congratulate him on having presented so good a view of the subject. As the development of our types was looked upon as the pattern for other countries, it would be unfortunate if we allowed it to be supposed that there was no basis for our classification, whereas no difference of opinion existed as to the main facts, viz., that the Cambrian rocks contained a large series of characteristic forms of life, and that the Silurian also contained a distinct series; the question was, *where* to draw the line between them. A classification taken from the Malvern country alone would be incomplete, as regarded both the series of strata and the forms of life. It was extremely difficult to apply the doctrine of the succession of life on the globe to minute cases, since the sets of fossils from adjacent quarries might differ, being determined by local circumstances. The term "system" of rocks as now employed, had no such distinct character as when it was first used by Mr Conybeare, whose systems were distinguished by conformity and mineral character, as well as by fossils. He wished not to express a positive opinion or to adopt arrangements which he regarded only as provisional; there had arisen before him a vision of a classification founded *entirely* on the succession of life, and he looked forward to the time when the nomenclature should express, not the local mineral changes,but those phenomena of organic life which extended over much wider areas.

Mr Strickland argued, that there had been no period at which organic life was absent from the globe, and no such thing as an entirely new creation; but that the changes in organic life had all been gradual. He did not think that even zoological terms would be universally applicable any more than that the same species would be found everywhere at the same time. The nomenclature must ever remain to a certain extent arbitrary and conventional. The value of the Cambrian and Silurian systems was not to be determined by the per-centage of identical species so much as by the zoological affinities of the genera and large groups of fossils; and in this respect they were apparently more allied than the Silurian was with the Devonian, or the Devonian with the Carboniferous system.

On the Surface Temperature and Great Currents of the North Atlantic and Northern Oceans. By the Rev. Dr Scoresby.*

The author commenced by pointing out the great importance to Physical Geography of the subjects which he proposed to discuss, particularly as they tended, in the economy of Nature, to furnish a compensating instrumentality against the extremes of condition to which the fervid action of the vertical sun in the tropical regions, and its inferior and more oblique action in the polar regions, were calculated to reduce the surface of the earth. Our knowledge of all the currents of the ocean, with perhaps one exception, the Gulf Stream, which had been, in its more important features, carefully examined and surveyed, and more especially in the American Coast Survey, was derived from the comparison by navigators of the actual position of the ship as determined from time to time, with its position as calculated from what sailors technically called the "dead reckoning," or the course steered, and the distance run as determined by the log, an instrument by no means perfect. The determination, however, of oceanic currents, to which the present communication referred, depends simply on induction from observation of temperature, and that mainly of the surface. Such observations, indeed, only become available under considerable differences betwixt

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the mean atmospheric and oceanic temperatures: and where they may seem to indicate the region from which peculiar qualities of the sea are derived, they can afford but little, if any, information as to the precise direction or strength of the current so indicated, yet still the general results are found important and useful. The researches of the author embrace those in the Greenland Sea, the North Sea, and a considerable belt across the North Atlantic. To those in the North Atlantic he wished at present to direct attention; and to a belt of it embraced within the limits of a series of passages chiefly by sailing vessels between England, or some European port, and New York. Of these passages, sixteen in number, four were performed by the author himself, and twelve were supplied by an American navigator, Capt. J. C. Delano, an accurate scientific observer. The observations on surface temperature discussed amount to 1153, gathered from a total number of about 1400. Usually Capt. Delano recorded six observations each day during the voyage, at intervals of four hours. Seven of the passages were made in the spring of the year,—two in the summer,—one in autumn,—and three in winter. Taking the middle day of each passage the mean day at sea was found to be May 18th or 19th,—a day fortunately coincident in singular nearness with the probable time of the mean annual oceanic temperature. The author had laid down the tracks of the ship in each of the voyages on a chart of Mercator's projection, and the principal observations on surface temperature were marked in their respective places. The observations were then tabulated for meridians of 2° in breadth, from Cape Clear, longitude 10° W., to the eastern point of Long Island, longitude 72° W.,—embracing a belt of the average breadth of 220 miles, or a stretch of about 2600 miles across the Atlantic. The results were the following: —1. Highest surface temperature northward of latitude 40°, 74°; lowest 32°; range 39°: 2. Mean surface temperature as derived from the means of each meridional section, 56°, whilst the mean atmospheric temperature for the corresponding period was 54°·2: 3. Range of surface temperature within each meridional section of 2°, 8½° at the lowest, being in longitude 20–22° W., and at the greatest 36°, being within the meridian of 62–64° W.: 4. Up to longitude 40° the surface temperature never descended below 50°;—the average lowest of the sixteen meridional sections being 51°·88, and the average range 11°·3: 5. In the succeeding fifteen sections, where the lowest temperature was 32°, the average lowest was 37°·1 and the average range 29°·7. This remarkable difference in the temperature of the eastern and western halves of the Atlantic passage, the author said was conclusively indicative of great ocean currents yielding a mean depression of the lowest meridional temperature from 51°·88 to 37°·1, or 14°·8, and producing a mean range of the extreme of temperature on the western side of almost thrice the amount of the extremes on the eastern side,—or, more strictly, in the proportion of 29°·7 to 11°·3. The author drew attention to a diagram in which he had laid down along the entire belt curves shewing the whole range of the lowest depressions of temperature and highest elevation, with the means at each longitude distinguished by different shading; and pointed out how the inspection of this as well as of the tabulated results affords striking indications of the two great currents, one descending from the polar, the other ascending from the tropical regions, with their characteristic changes of cold and heat. In classifying the results, the author considered the entire belt of the Atlantic track of the passages as divided into six divisions of 10° of longitude each, and these into meridional stripes of 2° each, omitting the first two degrees next the European end, or about 80 miles westward of Ireland to 72° W., or about the same distance west of New York. To each of these six divisions he directed attention, pointing out the conclusions to be derived from each. The curves approaching each other and running nearly parallel through the western half with great regularity, shewing the variations and range to be much less, while throughout the eastern half the widening of the distance, and the irregular form of the extreme curves shewed the influences of the two currents very remarkably. The author then proceeded to draw conclusions, shewing that sometimes the cold current from the north plunged beneath the warmer current from the south. Sometimes they divided,—the colder keeping in-shore along the

American coast, the other keeping out and forming the main Gulf Stream. Sometimes where they met they interlaced in alternating stripes of hot and cold water; sometimes their meeting caused a deflection,—as, where one branch of the Gulf Stream was sent down to the south-east of Europe and north of Africa, and another branch sent up past the British Islands to Norway and Scandinavia by the polar current setting down to the east of Newfoundland. The author next proceeded to consider the uses in the economy of Nature of these great oceanic currents. The first that he noticed was the equalizing and ameliorating influence which they exercised on the temperature of many countries. Of this he gave several examples. Thus, our own country, though usually spoken of as a very variable climate, was subject to far less variations of range of temperature than many others in similar latitudes,—which was chiefly from the general influence of the northern branch of the Gulf Stream setting up past these islands. He had himself on one occasion, in the month of November, known the temperature to rise no less than 52° in forty-eight hours, having previously descended in a very few days through a still greater range; while in these countries the extensive range between mean summer and winter temperature scarcely in any instance exceeds 27°, and in many places does not amount to nearly as much. Another advantage derived from these currents was, a reciprocation of the waters of high and low latitudes,—thus tending to preserve a useful equalizing of the saltness of the waters, which otherwise by evaporation in low latitudes would soon become too salt to perform its intended functions. Next he pointed out their use in forming sand-banks, which became highly beneficial as extensive fields for the maintenance of various species of the finny tribe, as in the great banks of Newfoundland. Next, this commingling of the waters of several regions tended to change and renew from time to time the soil of these banks,—which, like manuring and working our fields, was found to be necessary for preserving these extensive pastures for the fish. Lastly, by bringing down from polar regions the enormous masses of ice which, under the name of icebergs, were at times found to be setting down towards tropical regions, they tend at the same time to ameliorate the great heats of those regions, and to prevent the polar regions from becoming blocked up with accumulating mountains of ice which, but for this provision, would soon be pushed down as extensive glaciers, rendering whole tracts of our temperate zones uninhabitable wilds. Dr Scoresby concluded by pointing out several meteorological influences of these currents, by causing extensive fogs, and winds more or less violent.

On the influence of Climate on Plants and Animals. By Dr Emmons of New York.

It is difficult to determine the influence of climate on organized beings. The influence of climate seems, however, to modify what exists; it spends itself on those bounds, it does not form, but modifies varieties. Light, no doubt, should be regarded as an element of climate; its duration and intensity are indications of its force, and measures its activity. We see the foliage of a forest becoming more deeply green as we go towards a tropical region; the herbage of a species of forest tree becomes stiffer, rigid, and less leafy, as we go north, or ascend the mountains; and we may trace the changes in our ascent, until we find it a dwarf, a diminutive tree, a mere shrub, upon the heights of a mountain, while in the plain at its base it is a lordly tree. Those changes are unquestionably due to climate; they are not those which characterize varieties, much less species: indeed it is important that we do not assign too much to climate. Some naturalists have supposed that climate produces varieties; it seems, however, more consonant to facts to infer that varieties are independent of climate; that the causes which have been operating in the production of varieties have belonged to individuals. These forces or influences are begotten in a civilized state, or where many individuals are congregated.

It is not agreeable to the principles of natural history to maintain that the peculiar vegetation under a tropical sun is due to climate, or that it is an effect of climate. The species of plants belonging to the tropics differ entirely from the temperate ; their characters are those of different species, not varieties. When we trace the changes in a species of maple, as it approaches the confines of a temperate region, we may estimate the extent of change which is induced by climate. We cannot compare dissimilar species with those which grow in the south ; and, seeing that their differences arise from the influence of climate, because those differences are specific, they should be different ; and they may be greener, straighter, and taller, because those characters belong to them. But climate has influences, but not the influences in kind by which permanent changes are continued and propagated by the usual modes by which individuals are multiplied, as by cutting, grafting, layers, or budding. Take off the pressure of a cold climate, and the plant which has been pinched and shrivelled, or dwarfed, will mount upwards, and spread itself under a genial sun. It is probable that climate favours the development of certain varieties more than others ; indeed, there can be no doubt of the fact that varieties reach a higher state of perfection in certain climates than in others. If we study the habits of certain fruits, we shall find, and it is a fact well known, that they are very inferior, and even valueless, in some climates. The plum is fine and very perfect along the Hudson River ; but a few miles distant from it, it becomes inferior in quality. While, however, it is sufficiently manifest that varieties do not originate under the forces incident to climate, it is still difficult to point to causes which are directly operative in their production : it is, however, probable that a parental influence, those influences perhaps which are implanted for wise purposes, are effective in their development. Those species which are represented under numerous varieties, as the fruits and domesticated animals, have implanted in them a susceptibility to undergo those changes in their constitutions—it is, in fact, a part of their specific character ; it is of a higher grade in some of the domesticated animals than others, and it is incident to those animals only which can be domesticated ; and those which are easily domesticated have the power of multiplying varieties in the greatest numbers, and display the widest differences in the extremes. These views apply to

Man, who is more susceptible of change in his physical nature than any of the domesticated animals. Designed by the Creator to multiply and fill the whole earth, we find that his constitution is adapted to that end, to occupy all climates and adapt himself to a scorching sun or the frosts of a polar sky. Viewed in the extremes, the varieties in their physical character present differences which are very striking; viewed however in their intellectual and moral aspects, the characters are those of a unity. Their power of speech and language, the conveyance of ideas by speech is universal; this oneness of mind, which displays itself all over the world, the religious sentiment which is universal, point with significance to the singleness of the species. It must be so, or else Man is an anomaly in creation. Those who have entertained the theory of a plurality of species, which in their aggregate compose the human race, rely wholly upon physical characters to sustain their views. Considered even in this light, are the differences in the race so great that they would not have originated in the progress of time? Are the differences greater than in the breed of dogs and other domestic animals, which naturalists admit are of one species? In all cases those differences are external; they belong almost solely to the skin. If the bony skeleton is examined there are some differences it is true in their proportions, but those differences are found in each of the races respectively. The blacks have not all the flat noses, thick lips, and projecting jaws; there are whites with the same configuration of bone. But there probably has not existed a greater error in natural history than in classing man with animals, notwithstanding the fact that in his physical organization he is not very dissimilar to them; yet, in the common classification, his least important characters are made the characteristics; whereas really his higher attributes, those belonging to mind, and his moral nature, should have been made the characteristics. If this view be correct, we shall be troubled no longer with perplexities and doubts about the question of the plurality of species, inasmuch as there is such a perfect uniformity in the characters of Man in his mind as to stamp the truth upon the heart of every candid inquirer. The thoughts of Man are like one broad river, they flow in one channel; the speech of different races, which are widely separated, relate to subjects of the same kind; their belief in existence after death, of rewards and punishments, and all the strong castes of mind, move in one channel, and are harmonious in all their leading characteristics. Being destined to dwell on the earth for a season, it was fit and proper that he should, for that end, be furnished with what may be termed an animal nature; this nature belongs to the body, which is sustained, like that of animals, by food taken into the body, and air taken into the lungs,—a transient habitation for an immortal mind. The end required an apparatus adapted to the circumstances of his existence, and to the surrounding medium; but to make that apparatus the all-important part of his nature, to draw his characters from that, so transient, while mind, speech, articulate language, moral and intellectual attributes, religious sentiments, all of which are common to the races, does Man great injustice, and is an outrage upon his nature. This uniformity of sentiment is proved by an intercourse with all the tribes of men. If there were two or more species, we have a right to infer that this uniformity would exist. Of all the species which live, or have lived, is there any like it in the whole range of created beings, that two different species have intellects alike, or an ability to communicate purposes and intentions? If there are no cases of an analogous kind, it is plain that this uniformity of mental and moral views and feelings, and which are manifested in the same modes, should be taken as proof of the unity of the stock from which the races have sprung.

This subject is noticed cursorily, because it is one which is exciting a great interest; it is one of great importance, and it should be placed upon the right ground; and it is hoped that better and more correct views of classification should be embraced than those which have hitherto prevailed, and if Man is to be placed at all in a zoological classification, his characteristics should be drawn from his more essential attributes,—his intellectual and moral nature. If this view is correct, then, our inquiries will be directed to those powers as they exist in the various tribes of men. Climate, when considered in its relations to plants and animals, may be regarded, as I have already had occasion to remark, as a modifier of the existing species and varieties; but its modifications are restricted and confined: it sometimes favours the more perfect developments of varieties or species, and sometimes it operates in other locations where the climate is modified to restrain development and perfection. Climate never intermeddles with specific characters; it may for a time obscure those characters in a monstrous growth, when aided by a rich soil, or by over-feeding. A problem of great importance may be solved by observing what products are specially favoured by certain climates, and what climates are unfavourable to the production of the same. Where we have climate in our favour, and have not to contend with it, the expense of production is materially diminished; the certainty of the product is also increased, and its perfection secured, by which its value is also increased. As an element of climate, the temperature of the soil at different depths is one of great importance. The different soils may be said to enjoy different climates; those which are sandy possess a climate unlike that of a clay soil, a due admixture of sand and clay combine elements which belong to a climate intermediate between the two.

In pursuing our investigation in regard to species and varieties, it is highly important that we should be impressed with the fact that specific characters are permanent, and it will appear, on reflection, that this is a beautiful and wise arrangement. There is a fitness in the provision of individualizing species, as it were, both by corporeal marks and by intellectual and instinctive power. The intention or purpose which is fulfilled by this arrangement I do not intend to speak of now; it is the fact which I wish to bring before the reader. Many persons, however, when they speak of gradations of character, and of the intimate relations of things, and the links which bind all together, seem to labour under a fallacy. Where are those gradations seen, and what is the idea which is thus prominently set forth? What are the gradations of being? Is it probable that in the gradations which are insisted upon there is anything like a coalescence of species? I suppose the phrase, gradation of being, is often used with too much looseness, and hence it frequently happens that confusion results from its use; and it undoubtedly arises from misunderstanding the nature of the changes which have taken place in some species, and especially those which are represented by numerous varieties. These varieties are never generic, but strictly specific. Take the apple, which runs into many varieties; those varieties all retain the characteristics of the species. No apple has been found yet which has made the least progress towards the pear; neither has the pear yet transformed itself, in any of its varieties, into an apple; each and every one of them are equally removed from the genus, and yet each branches out into hundreds of varieties; and no one has the least doubt to which species any one of the varieties belong. The same is true of all the other species. There is no upward or downward movement in this; there is, it is true, in the case of fruits, a difference in quality, but none of them can be said to have made any progress toward an allied species. The constitutive power to multiply varieties is only a part of their specific characters. If we turn our thoughts to the animal kingdom for illustration of the same principle, for example, we find the elephant is apt to learn, while the rhinoceros or hippopotamus rarely possess this aptitude in the smallest degree; the positive character of the first is as important specifically, as the negative in the latter. If, then, by gradation of character, it is designed to convey the idea that species coalesce, by the resemblances in their varieties, the idea is erroneous; if, however, the phrase is designed to convey or express the fact, that in the system to which they belong, some species occupy a higher position than others, or that there are grades of development, some of which are high and others low, it is undoubtedly true. The position which a species holds is positive and arbitrary; species occupy a shelf or platform which is fixed, and it neither inclines downward nor upward; the position of the shelf, or in other words, the species, is nearer one than another species, that is, a species more closely resembles certain species than others. Although the distance between neighbouring species is unequal, still the two which are nearest akin never coalesce with each other through their varieties; even in vegetables, where they are susceptible of being engrafted or budded upon each other, there is no tendency to coalesce, or to produce an intermediate variety; the scion of the pear engrafted upon the quince is still a pear. There is, to be sure, a good reason for this: the pear is developed or formed in the cellular system, and really bears no connection with the quince, except by the sap, which flows upwards, and passes through the cellular system. The cells produced are only pear cells, yet it seems that if there were any tendency in the pear to become a quince, under any circumstances, the relation which the scion bears to the stock would be a favourable one. It appears necessary that a cell should be furnished from one of the parents, in order to produce an intermediate progeny, as is the case in the propagation of mules. But here we have unfailing test of the mixed parentage, from the sterility of the offspring, and although attempts have been made to prove the contrary position, still there is now no position better established than the one that the offspring of two different species of animals are sterile. It is true that, as in many other cases, there are no partial exceptions, still two mules cannot propagate a race.

Specific character is unchangeable, and species are kept in consequence of this arrangement strictly apart. There is an application of this fact to the products of our fields, which by some farmers are supposed to undergo a change. Chess is a plant which has but a slight relationship to wheat, and yet the question has been discussed for years, and many intelligent men in other matters have strenuously maintained that wheat changes to chess; the change of course must be by a single leap, in a single season—a complete somersault, a perfect degradation of the species in a single period of growth. When and where does the change begin? The point which troubles farmers, is the appearance of chess where they have sown wheat, and clean wheat too. But it is also notorious to every observer, that Nature too has sown her seeds broadcast, and where there is land in a condition for seeds to germinate, there they will spring up; and it comes to pass, from a wise provision, the tenacity of seeds for the vital principle ;* and chess, while fond of a good soil, springs up by the side of fences and fields, and scatters its seeds, which lie in the soil till favourable opportunities occur for their germination. The fact that chess grows where wheat is expected, is a trifling fact, which is easily accounted for on known principles, while the transformation of one species of plant into another is contrary to the laws which govern the growth and development of organized bodies. The only point which can be cited, and which is at all analogous to what appears a transformation, is the reversion of domesticated animals to their original appearance or condition ; as when the dog or hog is left to roam, and becomes wild in the forests, they resort back to their original condition, their original instincts returning as they become wild. Now, if it can be shewn that chess is the original of wheat, it might happen that where wheat springs up spontaneously and sows itself, it might in time become chess. But this hypothesis is unsupported by a single fact in the history of the two genera. The errors which have been entertained in regard to the transformation of wheat into chess have arisen solely from defective observation. Chess is observed in a wheat field, and becomes the more prominent and abundant when the wheat has been winter killed. Now it would be just as philosophical to maintain that the common wild cherry which springs up in our northern forests, where a windfall has occurred and swept down the pines, that the pines were changed into cherry trees ; these cherry trees cover the entire ground, and previous to the windfall not a cherry tree was to be found. The seeds of the cherry, however, lay in the ground, and when light and air was admitted by the destruction of the old forest, they spring up and cover the ground. The occurrence is not strange, except in the great abundance of trees produced ; and the occurrence of chess would not be regarded strange if but few plants made their appearance ; but when they become numerous,

* The phrase, vital principle, is used for convenience ; it is not designed by it to express an opinion in regard to the independent existence of something which presides over the movements of a living being.

the question comes up, where did all the seeds come from? The case is one which is common, it becomes prominent only from the relation which the plants wheat and chess bear to each other; looking like a grain in the midst of a grain field, being a hardy plant too, and springing up where it is not wanted, it has excited attention and imperfect observation, and in the end proving so worthless with its associates, it becomes prominent from its worthlessness. When we have ascertained the fact that seeds possess the power of retaining what is called vitality for a long period, that they may sleep in the ground for years, and then subsequently awaken into life, by heat and air, or favourable conditions; that all this is true, and eminently so of some seeds, the fact of the appearance of chess in an old field, or in a field prepared for wheat, ceases to be a mystery. It is only a fulfilment of a law of vegetation; it occurs in obedience to the characteristics which have been stamped upon organized beings by the Creator, in order that the earth shall be clothed with verdure, and not lie in a barren waste.

It has been maintained that species have a tendency to rise in the scale of existence, that they may change their own proper natures and become something else. Such a view is analogous to that which prevails among farmers about chess, has originated from defective observation, and has its source and beginning from misunderstanding the relations of organized beings to each other. It arises directly from the fact which has already been stated, viz. the closer resemblance which one species has to another than others of the same tribe. The pear has a closer resemblance to the apple than it has to the quince. The domestic dog has a closer resemblance to the wolf than the fox; and hence it has happened that the idea of an advance or change has taken a deep hold on the minds of some men; but there has been no change at all, not only are the species kept apart, but groups of organized beings also. Species, in their individual capacity, do not advance towards a higher, neither do they retrograde to a lower species. Plants do not deteriorate, neither do animals; but they retain all their specific characters.

There is another view which is interesting, viz., the manner in which domesticated animals break up into groups: it is illustrated in the dog, and all the domestic animals; but those groups retain the characteristics of the species, and of all the changes which take place not one affects the organization. The groups or varieties constitute well-marked families, and are capable of preserving their identities as species. While species, as the dog and ox, possess a constitutional ability to change their external characters, which are not specific, the change itself is governed by a law which, while it marks the groups with characters transmissible to their offspring, still not one group, or an individual of a group, is merged in any of the near or remote species. I remark again, that specific character is never destroyed by external influences; in those influences where a species is changeable, and readily breaks up into groups whose characteristics are transmissible from the parents to their offspring, the specific character is never uprooted; and in fact these external changes should be regarded as belonging to the specific characters. It is true that this susceptibility cannot be estimated or measured, as these changes are regarded as accidents or occurrences which cannot be determined by law.—(*Dr Emmons on the Natural History of New York.*)

On the Origin of Crystalline Limestones. By Professor A. Delesse.*

M. Delesse, having just previously reviewed the general characters and mineral contents of different crystalline limestones,† commences this communication by defining "metamorphic limestone" and "metamorphic rock," as a rock which has been subjected, at a period posterior to its formation, to considerable modifications in its physical or chemical properties. These modifications are brought about by the development of diverse minerals, by changes in its structure of aggregation, or in its structure of separation, as well as in its chemical composition. The modifications in the physi-

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* *Bullet. Soc. Geol. France.* Deux ser. tome ix., pp. 133–138.

† *Loc. cit.*, pp. 120–133. See also papers by MM. Delesse, Cotta, and Scheerer, *supra*, pp. 4, 15, and 19, *et seq.*—*Transl.*

cal properties of the rock result from the action of heat, electricity, magnetism, pressure, as well as of all the agents that can bring into play molecular attraction and repulsion. The modifications in its chemical properties arise from the introduction of new substances in the rock, by injection, sublimation, secretion, cementation, and especially by infiltration.

M. Delesse then observes:—" It appears to me that the crystalline limestones should be considered metamorphic, though certainly they are metamorphic to very different degrees; still they have all been subjected, since their deposition, to modifications in their chemical, or at least their physical properties. There are, however, some limestones that form an exception, namely, those which have been deposited by chemical precipitation, and which were originally crystalline. These are not to be confounded with the metamorphic crystalline limestones, nor do they contain the mineral characteristics of the latter.

The crystalline limestone of the gneiss of the Vosges, which, from its mineralogical and geological characters, M. Delesse considers to be a metamorphic limestone, is then particularly adverted to; its characters are succinctly described; and M. Delesse proceeds to say, that probably the limestone was originally deposited, either in mass from water charged with carbonate of lime, or as strata by the waters of the sea. The beds in which the limestone has been intercalated belong without doubt to certain divisions of the Transition group; and, moreover, all geologists who have studied the Vosges have regarded the gneiss inclosing the limestone as metamorphic.

The phenomena that have produced the metamorphism of the gneiss are unknown; but a group of strata could be transformed into gneiss only by the introduction of the quantity of alkalies necessary for the production of the felspar, one of the constituents of the gneiss. Further, heat must have been effective in the development of the crystalline structure of the limestone of the gneiss, since the limestone contains spinelle, chondodrite, garnet, amphibole, pyroxene, &c.; that is to say, minerals of an igneous origin, since they are found in the limestones on the flanks of Vesuvius, or in the sphere of action of other volcanoes now active, such as those of Teneriffe, Ponza Isles.* On the other hand, there could not have been complete fusion; for in the crystalline limestone of Norway, MM. Naumann and Keilhau have observed fragments of corals.†

The nature of the very numerous minerals of the crystalline limestone also gives great improbability to the hypothesis of complete fusion. It appears, indeed, that rocks which have been reduced to a fluid state, and which have had an igneous origin, such as lavas, have always a very simple mineralogical composition. They are essentially formed of two minerals: the one of the felspar class, in which are concentrated the alumine and the alkalies; the other of the pyroxene or peridote kind, in which are concentrated the oxide of iron, magnesia, and lime. In "crystalline" limestone, on the contrary, there are various silicates, sometimes with a single base, sometimes with many; and these silicates are often associated either with free silex or with silicates, not saturated with bases. Moreover, together with these silicates, there are very energetic uncombined bases, such as magnesia (periclase), alumine (corindon). There are also metallic oxides, such as the oxides of iron, which, under certain circumstances, appear to have been contemporary with the limestone; and there are compound oxides, such as the spinelles, perovskite, in which the oxide, playing the part of an acid (alumine, titanic acid), is an acid much less energetic than the silex. We easily comprehend, then, that these minerals have been formed with the concurrence of heat, or of the molecular actions which it developed; but it is difficult to admit that they result from a complete fusion of the crystalline limestone.

Moreover, many facts prove that felspar may be formed in rocks without the intervention of a great heat; for example, in the Arkose of La Poirie (Vosges), crystals of felspar are developed in the clay lands (argilolites), which certainly have not been melted, and the stratification of which is quite

* Dufrenoy, *Ann. des Mines*, 3 sec., tome xi., p. 385.

† See also Translation of Professor Scheerer's Memoir, *supra*, p. 7.—*Ed.*

recognisable. At Morel, in the commune of St Laurent (Saône-et-Loire), crystals of pink orthose of an after development exist in a limestone with *Gryphæa arcuata*, which has a crystalline structure, but characterized by a grayish yellow tint somewhat different from its usual colour. Lastly, at Steinmal felspar crystals have been observed by M. von Dechan in the inside of the abdominal buckler of a *Homalinotus.* In the same manner, the transition graywackes in the neighbourhood of Thann, and to the south of the Vosges, are very often completely impregnated with felspar, and still we find in them numerous remains of plants which have been well preserved in spite of the later development of crystals of felspar of the sixth system.

The intimate and mutual penetration of the limestone and gneiss, shews that both have been reduced to a plastic state, if not to actual fluidity; and the dissemination of the felspar in the limestone mass, shews also that the gneiss must have been sufficiently pasty for the felspar to have been secreted.

The penetration of the limestone by the gneiss, as also the undulations sometimes presented by both rocks at the line of junction, make it evident that pressure was brought into play to a great extent during the crystallization of the gneiss; this has produced in the limestone fissures generally parallel to its line of contact with the gneiss, and comparable to those formed in a book the leaves of which are squeezed or pressed back laterally. Those fissures have been immediately filled by the secretions of matter diffused in the limestone, and they have given place to the parallel zones of nodular concretions, whilst the same matter formed the veins or the lining in fissures of the gneiss. Although in most of the metamorphic limestones the minerals are especially developed in the natural joints, originating in stratification, these nodules, on the contrary, in the limestone of the gneiss of the Vosges, apparently owe their parallelism to pressure.

Pressure, like heat, has been also effective in actuating molecular attraction, and in developing the different minerals disseminated in the limestone.

Subsequently to the crystallization of the limestone and of the gneiss, certain minerals have been, and probably are still being, modified by chemical action arising from infiltration, so that new minerals are formed by pseudomorphosis; as for example, the pyrosklerite.—(*T. R. I. Quarterly Journal of the Geological Society*, Vol. ix., No. 36, p. 27.)

Biographical Sketch of Mr Hugh Edwin Strickland.

We have to announce, with deep regret, the death of Mr H. E. Strickland, who was killed by a railway train, whilst examining the strata of a railway cutting on the Manchester, Sheffield, and Lincolnshire line.

"Mr Strickland arrived at East Retford from Hull, having attended the recent meeting of the British Association. He was attached to the Geological Section of the Association; and in pursuance of his practical investigations in that science, he proceeded on Wednesday afternoon to examine the strata of the deep cuttings on each side of the Clarbrough Tunnel, about four miles distant from Retford. A little after four o'clock, a boy at work in the fields observed him standing between the two lines of rails, near the mouth of the tunnel, on the Gainsborough side, with a pocket-book in his hand, apparently engaged in making notes. At this time, a coal train was approaching on the down line,—to avoid which he stepped off the 'six feet' on to the up line;—but unhappily he did so just at the moment when the Great Northern passenger train was issuing from the tunnel. The train dashed upon him,—and the next instant he lay a shattered and shapeless corpse."

Mr Strickland was in the prime of life,—at that age when the promise of youth is fast realizing itself. He was born at Righton, in the East Riding of Yorkshire, on the 2d of March 1811. His father, Mr Henry E. Strickland of Apperley, in Gloucestershire, was a son of the late Sir George Strickland, Bart. of Boynton, in Yorkshire. He was a grandson on his mother's side of the celebrated Dr Edmund Cartwright,—whose name is so indissolubly connected with the manufacturing greatness of England on account of his invention of the Power-loom.

Mr Strickland's boyhood was spent under his father's roof; where he was under the private tutelage successively of the three brothers Monkhouse,—one of whom is now a fellow of Queen's College, Oxford. From his father's house he was transferred to the late Dr Arnold,—who, prior to his appointment at Rugby, took private pupils at Laleham, near Staines. He finished his education at Oriel College, Oxford.

Although distinguished for his classical knowledge, Mr Strickland had early acquired a taste for natural history pursuits; and after the completion of his studies at college he resided with his family at Cracourt House, near Evesham, Worcestershire—where he studied minutely the geology of the Cotswolds and the Great Valley of the Severn. Some of his earliest published papers were on geology; but his first effort as an author indicated a taste for the pursuits of his maternal grandfather. It appeared in the *Mechanics' Magazine* for 1825,—and was on the construction of a new wind-gauge.

In 1835, Mr Strickland travelled in Asia Minor, in company with Mr W. J. Hamilton, M.P.,—who was then Secretary to the Geological Society. An account of this journey was published, in two volumes 8vo, by Mr Hamilton, in 1842, under the title "Researches in Asia Minor, Pontus, and Armenia." This tour resulted also in the publication of several interesting papers on the geology of the districts visited, both by Mr Strickland himself and conjointly with Mr Hamilton. The principal papers published by Mr Strickland singly were —"On the Geology of the Thracian Bosphorus,"—"On the Geology of the Neighbourhood of Smyrna,"—and "On the Geology of the Island of Zante." He early devoted his attention to the study of birds; and during this journey he gave proof of his ornithological knowledge by adding to the list of birds inhabiting Europe the *Salicaria Olivetorum*. He subsequently devoted a large share of his attention to the study of birds;—as his papers in the "Annals and Magazine of Natural History," and in Sir William Jardine's "Contributions to Ornithology," amply testify. His principal work, however, on this subject, and the one which will give him a place amongst the classical writers on the ornithology of this country, is devoted to the history of the Dodo. This work was published, as our readers will remember, in 1848,—with the title "The Dodo and its Kindred; or, the History and Affinities of the Dodo, Solitaire, and other Extinct Birds." It was handsomely illustrated; and was an example of how the difficult subject of the affinities of extinct animals should be dealt with. Mr Strickland was aided in the osteological portion by Dr Melville. Since the appearance of this work, he has twice published supplementary notices regarding the Dodo and its kindred, in the "Annals and Magazine of Natural History." One of Mr Strickland's last contributions to science was on the subject of ornithology,—when, in the Section of Natural History, the day before his death, he gave an account of the Partridge (*Tetraogallus*) of the Great Water-Shed of India, recently illustrated in Mr Gould's "Birds of Asia."

Although as a zoologist ornithology was his strong point, Mr Strickland had an extensive knowledge of the various classes of organized beings. Thus, several of his papers were devoted to accounts of the Mollusca, both recent and fossil, in various districts. One of his papers at the last Meeting of the British Association at Hull was, as our readers will see elsewhere, "On the Peculiarities of a Form of Sponge (*Halichondria taberea*)."

Mr Strickland paid a large share of attention to the terminology of Natural History,—and was the reporter of a Committee appointed by the British Association to consider the rules by which the nomenclature of zoology might be established on a uniform and permanent basis. These rules were principally drawn up by him; and they have since their publication been very generally acted on,—and have contributed greatly to simplify Natural History nomenclature.

The general principles of classification could hardly fail to interest a mind so discursive as his,—and accordingly we find him at various times publishing on this subject. In an early number of the "Annals and Magazine of Natural History" he inserted a paper "On the true Method of discovering the Natural System in Zoology and Botany,"—in which he displayed a great knowledge of the forms of animal and vegetable life. In the reports of the British Association for 1843 he published a paper "On the Natural Affinities of the Insessorial Order of Birds;" and again, in the "Magazine of Natural History," vol. ii.,—"Observations on the Affinities and Analogies of Organized Beings."

It must be obvious, that the labours to which we have alluded imply an immense amount of industry,—but in the midst of all his practical investigations Mr Strickland found time for purely literary work. Thus, in 1847, he undertook to edit for the Ray Society a work, the collection of materials for which had cost Prof. Agassiz many years of labour, entitled "Bibliographia Zoologiæ et Geologiæ." Three volumes of this great work are published, and the fourth and last is now in the hands of the printer. Mr Strickland's labour here was not merely that of editing—it embraced the contribution of a large mass of additional matter, amounting to a third or fourth of the whole. He spared no pains to make this work complete;—and it must ever be regarded by the zoologist and the geologist as a most valuable gift to the sciences which they cultivate.

On the occurrence of the illness of Dr Buckland, and his withdrawal from the duties of the chair of Geology at Oxford,—every one felt the propriety of inviting Mr Strickland to deliver lectures in his place. Though young for so important a post, and with a reputation in other departments of science, he was found able to sustain the fame of his predecessor in this,—and brought to bear with great advantage the stores of his varied knowledge upon a science which is always susceptible of influence and amplification from the principles of other departments of science, however distant from it they may at first sight appear. The Reports of the British Association, the Transactions of the Geological Society, the papers of the Quarterly Journal of the Geological Society of London, and of the London and Edinburgh Philosophical Magazine, all testify to Mr Strickland's activity as a geologist. They contain a mass of valuable observations both on palæontology and on the physical structures of rocks in this country and other parts of the world,—which must for ever remain a part of the history of the science of geology, and constitute a permanent monument of the industry and earnestness of the man who made them.

In several of his geological papers, Mr Strickland's name is connected with that of Sir R. I. Murchison; especially in a work on "The Geology of Cheltenham and its Neighbourhood." He assisted Sir Roderick in preparing for the press his great work on the Silurian system; and the proof-sheets of his new work on Siluria all passed through Mr Strickland's hands,—the last of the work having been corrected at Hull.

At the time of his death, Mr Strickland was engaged in working on his "Ornithological Synonymy,"—the printing of which was delayed only to render it more full and complete. He possessed a very ample and useful library,—also extensive geological and ornithological collections,—which are now at his residence at Apperley Green, near Tewkesbury.

In 1845 Mr Strickland was married to the second daughter of Sir William Jardine, Bart:—both of whom, with Mr Strickland's father and mother, survive to lament his premature loss.

In the above brief sketch we have spoken only of Mr Strickland's scientific career,—but he had moral qualities that endeared him to all who knew him. Few came in contact with him who did not recognize in him a conscientious, amiable, and excellent man. In him Oxford has lost a Professor whom she could ill afford to part with at this time. To him they who hoped for the wider culture of natural science at Oxford looked as to one who had the power and the ability to take a lead. The scientific societies have lost in him a member who was unwearied in his assiduity to carry out their objects in all their purity. His means made him independent of his labours;—and all recognized in his exertions that love of science and its objects which constitutes the true philosopher.—(*Athenæum*, No. 152, p. 1125).

Notice of an Attempt to Naturalize the Craw-Fish (Astacus fluviatilis) *in the South of Scotland.* Communicated by Dr FLEMING.

The following curious entry occupies a place in a volume of *Adversaria* (for 1770, p. 4), formed by Dr Walker, Professor of Natural History in the University of Edinburgh, the immediate predecessor of the present occupant of the chair.*

" *Cancer Astacus*, Lin. (The Cray-Fish).

" They abound in the rocky rivulets about Penrith, in Westmoreland, which run upon limestone.

" They spawn in the months of June and July. They were brought from Penrith seven years ago, and planted in the rivulet which runs past the house of New Posso, where they still live.

"Graham, who brought them, informs me that the best time for transporting them is about the 1st of May. He carries them in a close basket among wet grass, which he deposits in water at night. Three days and three nights is the longest time that they can be so carried with safety. He can carry on horseback about 1000. He took them to Kailzie in Tweeddale for 13s. 6d. per hundred, but most of them died. He offered to bring them to Moffat for 8s. 6d. per hundred if 1000 were taken. He feeds them sometimes with beels.

" To Robert Graham at Penrith, to the care of Mrs Buchannan, at the Crown in Penrith.

" The way to catch them or to know if they are in a rivulet, is to put in a lump of flesh or any carrion into it over night; they will be found preying upon it in the morning."

It appears from the preceding statement that this crustacean, even in those days of difficult transport, was successfully conveyed from Cumberland to the parish of Manor in

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* Seven volumes of these *Adversaria* which came into my possession, containing many important notices of interesting subjects in Natural History, have been deposited in the Library of the University.

Peebles-shire, and that they outlived their translation throughout a period of at least seven years.

The late distinguished zoologist Sir John Graham Dalyell, Bart., instituted, at my request, a series of inquiries for the purpose of ascertaining if the descendants of this stock were still to be found in the places referred to, but all traces of such animals had disappeared, and even tradition, usually a tolerably faithful record, had preserved no memorial of the experiment.

It would be a very easy process at the present time, with the command of railway speed, to transport the animals from their native haunts to any of our suitable streams; while such an addition to our luxuries would not interfere with any other source of enjoyment.

Pennant, in his "British Zoology," terms the crustacean CRAW-FISH; but Berkenhont and later writers term it Cray-Fish. J. F.

NEW COLLEGE, EDINBURGH,
3d December 1853.

On the apparent Visibility of Stars through the Moon immediately before their Occultation. By R. EDMONDS Jun., Esq. Communicated by the Author.

Eight years ago, when the cause of the occasional projection of a star on the moon's disk for a few seconds before its occultation was, at one of the meetings of the British Association, and elsewhere, publicly discussed by eminent scientific men, I prepared a short paper, suggesting that it might arise from the telescope being on such occasions set to the star's focus instead of the moon's, in which case the imperfect image of the moon formed at the stellar focus would, of course, be magnified. But when the star is on the very edge of the moon, the image of the latter would not find room for being magnified without spreading itself over the star's image, and thus occasioning the apparent visibility of the star through the moon, the extent of this projection being equal to the excess of the radius of the magnified lunar image beyond that of its perfect image when brought to a focus. In the occultation of the star Aldebaran in 1829 the reason why eight of the thirty-one European observers did *not* perceive any projection, and that the other twenty-three *did*, may be, that the telescopes of the former were suited to the lunar focus, and those of the latter to the stellar; the eye being incapable of determining the *exact* focus.

I did not, however, publish my remarks, nor shew them to any one until last month, when my nephew (Frederick B. Edmonds) being here on a visit, I desired him to read them, with a view to test by experiment the correctness of my explanation. He accordingly placed a candle in the furthest corner of the room close behind a card, through a small hole in which the light flowed to represent a star. At the distance of about two yards from the candle he placed an illuminated disc to represent the moon; and then retiring three yards from the disc, with a powerful pocket spy-glass, having its focus set for the "*star*," looked at the "star," along the edge of the "moon," when the former appeared very clearly projected on the latter, precisely as in the reality observed by astronomers. When the focus of the glass was set for the "*moon*" no projection whatever occurred.

I immediately communicated this to Professor Airy, who very kindly informed me that the explanation would be satisfactory if the focal length of the telescope for the moon were sensibly different from that for the star. "It would be highly desirable, however, (he added,) to bear this consideration in mind in the case of another observation of the occultation of a bright star."

The explanation now offered will therefore, in all probability, ere long be fully tested; and if the eye be unable *directly* to detect any difference between the lunar and stellar foci, the existence of a sensible difference between them would, I presume, be *indirectly* established, should the projection disappear on lengthening the focal distance, and reappear on shortening it.

On the Paragenetic Relations of Minerals.

(Continued from vol. lv., page 352.)

Lode Formations.

By the term lode formation is to be understood a small group of minerals usually associated together in lode fissures, and presenting distinctive characteristics in their mode of association. At the same time it must be added, that groups of minerals can only be regarded as constituting any one formation so long as the succession of the individual minerals in what is termed the lode structure, or banded arrangement of the minerals, remains the same. Repetitions or successive generations of a formation likewise occur.

There is considerable difficulty in determining and distinguishing the lode formations: thus, 1. Certain minerals occur in different formations, and some one mineral, especially quartz, is often repeated, without the remaining members of the group. 2. Some minerals, as iron pyrites, some varieties of calcite, and copper pyrites, occur in so many formations, that they cannot be regarded as distinctive. Still formations are sometimes characterized by the quartz and the particular abundance of pyrites. 3. In some instances druses are very rare in lodes, and it is only in them that the structure and succession of the minerals can be recognised. 4. Sometimes there are two or three formations in one lode, and then it is not always easy to determine whether a mineral belongs to one or the other.

It appears that the minerals which serve best to distinguish the lode formations are either some of those siliceous species which are not products of decomposition, or some of the true ores. There is still a want of some kind of scientific nomenclature for these phenomena, but the paragenetic relations are perhaps too little understood, and the relative dates of lodes too little known, to warrant the adoption of one as yet. Nevertheless the paragenetic grouping of a few but constant minerals in lodes is too evident to escape notice. Such, for instance, is the case with minerals containing cobalt, nickel, bismuth, and arsenic; lead and zinc; tin and scheel, and the very frequent association, under similar conditions, of fluor spar and heavy spar. Undoubtedly it is not allowable to form an opinion on this subject from individual specimens in mineralogical cabinets; it is the universal association of minerals in the different known lodes of one class which must be studied.

Moreover, the determination of lode formations is not alone difficult in regard to the constituent minerals, but likewise in regard to the date of the several substances. When different formations occur together in one lode, or in different lodes intersecting each other, some inference may be formed as to their relative dates; but as yet there are only a few such instances of contact known, and therefore this branch of research, so important in its relation to mining, yet remains to be cultivated.

The following description of lode formations comprises both such as have a practical interest, and such as at present have only a scientific interest; they are likewise arranged according to probable relations of date, commencing with the older.

I. *Pyroxene, garnet, pyrites, and blende formation.*—This is undoubtedly one of the oldest, perhaps the oldest, of all lode formations, although want of acquaintance with its contact phenomena renders this still uncertain. The character of these lodes is not very distinctive, since the lode planes are frequently parallel with the strata adjoining; for which reason they are very generally regarded as beds. Again, the banded structure is almost altogether wanting. The formation, however, is marked by the occurrence of silicates, sometimes in considerable masses; a circumstance which strongly indicates a very remote date. It is probable that the lode substance of this formation bears a relation to the adjoining rock similar to that of amygdaloid rock to old red sandstone, where it has penetrated the latter, and yet occurs in parallel layers. Thus the date of the lode substance would be much the same as that of the adjoining rock; and indeed, in a geognostic point of view, it appears to resemble the eruptive rocks, as if it had been injected, which may be the reason of the absence of banded structure.

This formation occurs in Saxony, Bohemia, and Scandinavia. Its constituent minerals are specifically different from the same minerals occurring in rocks. Pyroxene appears to be the oldest member, idocras and garnet more recent. Pseudomorphs are by no means wanting. It is further remarkable, that at different parts one or other mineral predominates considerably. Thus the accumulations of galena, iron, copper pyrites, tin ore, and even limestone, have been found sufficient to admit of being worked.

The general features of this formation present great analogy with those of the "kalkstöcken," previously spoken of. While in these latter, limestone predominates, and in some localities there is a much greater diversity of imbedded minerals, and the lode form appears less marked, the occurrence of limestone in the former is only exceptional; but, on the other hand, there is an abundance of pyroxene, garnet, and pyritic minerals, which is foreign to the "kalkstöcken," and the lode character is more distinctly marked.

II. *Titanium formation.*—This is probably little inferior in antiquity to the last, not only because it occurs in the oldest known rocks, but because the essential constituent minerals, containing titanic acid, do not occur in any other formation, with the sole exception of the "kalkstöcken" and divergent zones. Felsite is likewise found upon them, which certainly indicates a very remote date.

The phenomena presented by the lodes of this formation appear to admit of the following inferences: 1. That the felsites are in all instances older than the compounds of titanic acid, or of titanic and silicic acid together. 2. Quartz is generally more recent than the above minerals, except rutil, with which it appears contemporaneous, and sometimes even older than it.

III. *Noble quartz formation.*—This occurs in Saxony, especially in mica-slate, sometimes in gneiss, both rocks being much altered. It is older than the porphyry veins with which it comes in contact, but these veins appear to bear some relation to the richness of the lodes. The principal lode substance is quartz, frequently converted into hornstone, generally adhering firmly to the adjoining rock, and ramifying into it. Large masses of ore never occur in these lodes, which are therefore worked only in virtue of the silver and gold present in the minerals they contain. The Saxon lodes of this formation are especially characterized by a variety of mispickel, in small crystals with a brilliant lustre, generally imbedded in quartz, and very rarely implanted upon it. There is always some gold in this ore, although, in most instances, not sufficient for profitable extraction. It is, indeed, very possible that the presence of argentiferous blende and glance, as well even as that of metallic silver, was determined by this mineral.

There are good reasons for the opinion that the lodes of this formation are intimately connected, as regards their origin, with metamorphic phenomena in the adjoining rocks, and that they are on a larger scale essentially the same as the small and sometimes metalliferous quartz veins in felsite rock and porphyry.

Antimony, tellurium, and arsenic, constitute, by reason of their analogy, a mineralogical and chemical group, and their natural compounds frequently appear to belong to one and the same lode formation. Antimony glance always contains traces of gold and silver, in some localities sufficient for extraction, and it is very probable that the Transylvanian lodes bearing quartz with auriferous and argentiferous tellurium minerals, and even metallic gold, are of this class.

The gold occurring in lodes of this formation is very recent, being implanted upon antimony glance, iron pyrites, calcite, realgar, and even gypsum. In like manner, silver appears to be the most recent member of the formation; consequently it is hardly to be doubted that these metals have originated by some mode of extraction from compound minerals.

IV. *Pyritic lead and zinc formation.*—This very closely resembles the last-mentioned formation, from which it is separated only on account of the peculiar character communicated to it by the considerable masses of galena, black zinc-blende, arsenical iron, sulphur, and magnetic pyrites, and the absence of any considerable quantity of gold or silver in them. Generally speaking, these minerals have been converted into pseudomorphic bisulphurets. The presence of copper pyrites is likewise distinctive; the edle quartz of Freiberg is, moreover, intersected by porphyry, while this formation intersects porphyry. Assuming the porphyry to be of the same date, this would support the opinion of miners who regard the formations as different. Still there are no grounds for dividing the pyritic lead and zinc formation into so many parts as Werner did. On the other hand, it cannot be doubted that there are several formations of galena and zinc-blende, for instance, the clinoedritic and the barytic. But these two minerals frequently occur together elsewhere without any recognisable relations to other minerals as regards date having yet been ascertained, therefore the possible future necessity for further subdivision must not be altogether denied. The zinc-blende is almost always the black variety, especially when associated with arsenical pyrites, and indeed whenever pyritic minerals preponderate. When it is of a brown or red colour there is seldom much if any pyrites near. It is well known that black zinc-blende contains an essential admixture of sulphuret of iron, and has a lower specific gravity than that of any other colour.

The clineodritic lead and zinc formation sometimes directly follows the present one; however they must nevertheless be regarded as distinct.

Sometimes the heavy spar formation is likewise present with and without the noble quartz ores, which are, however, less abundant the greater the quantity of pyritic minerals, and in this case belong to a more recent formation which has been sporadically imbedded in that of the latter, as is the case in the noble quartz formation, where such lode substances are generally absent.

The pyritic ores are met with, although quite in miniature, in the fissures of argillaceous spherosiderites, the lode veins of coal strata, and even in the cavities of limestone petrifactions of still more recent date.

The minerals constituting this pyritic lead and zinc formation are frequently mixed together in coarse masses, no constant succession being observable except in the druses which sometimes occur where the lode bellies out, when galena and zinc-blende present themselves as the older, and pyrites as the younger members. Two generations have likewise been observed, thus upon galena and blende—mispickel, and then again galena and mispickel. Derivatives of galena are rare, those of copper pyrites unknown.

This is perhaps the most important formation for the mining of Freiberg, for only a small part of the silver which is obtained there is derived from the true silver formation, the principal part being extracted from the galena of this formation.

It is in connection with this formation that we first meet with a phenomenon called by the miner, the iron hat, gossan. It has been universally found that iron ores, especially brown iron ore, red hematite, and even specular iron ore, are met with only at the upper part and outcrop of the lodes, which, when worked deeper, yield ores of more valuable metals. There is indeed historical evidence that the working of iron ores has laid bare ores of silver, lead, copper, cobalt, and nickel, and in many districts the proverb is still in use—

> "Der Gang hat einen eisernen Hut,
> Und thut darum in der Teufe gut."

It is scarcely probable that this phenomenon can in all cases be accounted for in a similar manner. It is met with in lodes of the pyritic lead and zinc formation in some of the Freiberg mines, and there it may have originated from the action of the atmosphere upon pyritic minerals. There are brown iron ores which are remarkable for containing silver sometimes in available quantity, called in Germany "edle Braunen" and "Gilben," in Mexico "Pacos." It is possible that in the earlier periods of mining in Germany, the belief in the "eisernen Hut" was more universal than at the present time; but in Mexico and South America it still maintains its ancient authority, and has recently received a confirmation in the discovery of the lead and silver mines at Jarosa, near Alicante in Spain. But the presence of silver in the iron hat is not essential. Probably the knowledge of its occurrence has contributed to the confirmation of the opinion that the deeper a lode is driven the greater is the probability of finding rich deposits of ore, although in this instance there is another genetic reason for the belief than that previously spoken of.

At other places the large number of pyritic minerals are wanting, and are replaced as at Prizebram by spathic iron. Here the "hut" may originate from the alteration of spathic iron. In the neighbourhood of Prizebram, the lodes of iron ore are leased to private individuals only to a certain depth, because the more valuable pyritic ores occur below that depth, and these are worked by the government.

At other places, the various iron and manganese ores of the "eisenen Hut" are certainly more recent than other minerals on the same lodes, and present a genetic character distinct from them.

Although it is true that most lodes of iron ore continue as such to all accessible depths, still some of the deposits of ferruginous minerals ought not to be altogether overlooked or disregarded, especially when they occur in true lode districts, for it is probable that in many instances such a deposit may be the iron hat of a lode.

V. *Cobalt and Nickel formations in general.*—Not only are minerals containing these elements very generally associated together, but in almost every mineral which contains one of them as an essential constituent, at least traces of the other enter its composition. Arsenic enters more largely than sulphur into the composition of the more frequent of these minerals, so that it might be termed the cobalt, nickel, and arsenic formation. Metallic arsenic has even been found. Bismuth minerals are in some localities such constant associates that they might be regarded as essential, while in others they are altogether absent. However, they occur unaccompanied by cobalt and nickel minerals, although the arsenik-kies of Altenburg contains nickel, and bismuth glance is a frequent associate of copper pyrites.

Copper pyrites, and sometimes its ordinary products of composition, especially malachite, kupperfecherz, accompany the minerals of this formation. Linneite is never without copper pyrites, although large masses of it have not been found. Arsenical iron pyrites occurs, though not largely. The uranpecherz occurs sporadically, especially in one group of this formation.

The principal lode substances (gangarten) are spathic iron of twelve periods, and partly converted into brown iron, principally as support, pearl spar, fluor spar, heavy spar, quartz, (three generations), calc spar (three sub-species), brown spar and tantokline.

It has been ascertained that only those arsenical pyrites which are accompanied by chlorite, contain nickel with traces of cobalt. The cobalt minerals of Chili occur in chlorite slate. The schaalstein of Nassau bearing lodes of cobalt and nickel is a greenish clay-slate, approximating closely to chlorite slate, and perhaps actually passing into it. It is considered, perhaps correctly, as clay-slate, altered by the adjoining chlorite slate. The metallic bismuth of the tin formation is accompanied by chlorite, and a number of facts lead to the inference that these formations are peculiar to the chloritic rocks.

Diorite, one of whose principal constituents is amphibole, contains gelbnikelkies at Gladenback (Darmstadt),—only indeed disseminated, but so abundant as to be worked. The spathic and brown iron lodes at Lobestein bear nickel and cobalt minerals principally when they cut through or pass near diorite, while in the clay-slate they are either scarce or absent. The principal deposits of nickel and cobalt are chiefly in amphibolic rocks. The magnetic pyrites of Lillehammer (Norway) and Klefwa (Sweden), containing 3 to 4 per cent. nickel, and nearly 1 per cent. cobalt, occur in amphibole and diorite rocks. Breithaupt has found that these magnetic pyrites closely resembled that from the Adlers mine (Bavaria), and Plattner found in it 1 per cent. cobalt and a trace of nickel. The magnetic pyrites of Lillehammer and Neufang contain fragments rather than crystals of amphibole, which leads to the conjecture that they are the contents of lodes.

It is further remarkable that even in meteorites, magnetic pyrites accompanies the iron containing cobalt and nickel. Traces of nickel have been found in olivine; and peridotes are present in many meteorites.

The numerous instances of the paragenesis of minerals containing cobalt and nickel in amphibole and dioritic rocks, are not less remarkable, and must not be overlooked, as is sufficiently indicated by the above-mentioned occurrence of cobalt and nickel in magnetic pyrites.

However, this formation occurs in true clay-slate, and likewise in mica-slate, gneiss, and granite, although only sporadically. Its occurrence in zechstein and cupreous slate is altogether distinct from its appearance in lodes in the above-mentioned rocks.

Older Cobalt formation in Chili.—This formation is stated to have been discovered near Huasco in chlorite slate. The Schneeberg cobalt nickel lodes likewise bear axinite, and these two instances of association induced Breithaupt to examine the arsenical pyrites of Thun, sitting upon axinite, for cobalt, which it was found to contain. It would therefore be advisable to examine pyritic minerals associated with axinite, in order to ascertain whether they contain an available quantity of cobalt and nickel.

Glaucodot likewise occurs porphyritically in chlorite slate, with precisely the same characters as the mispickel in Freiberg mines, except that here the adjoining rock is disintegrated, which is not the case with Chili chlorite slate.

VI. *Tin formation.*—The principal representatives of this formation are tin ore (cassiterite) and the two wolframites, ferro-wolframite and mangano-wolframite. These minerals are associated wherever tin ore is worked, and the isolated occurrence of one or other is a great rarity. The scheelspar is without doubt to be regarded as a product of the decomposition of wolframite. Beryl and topaz occur together and separately, the former as a very old member of the group. Quartz is never absent. The formation likewise includes such pyritic minerals as contain an essential admixture of arsenic, rarely such as are free from that element. Molybdenum glance is a frequent mineral. Calcite and most carbonates, so frequent in other formations, are here very scanty.

One especial characteristic of this formation is the very limited number of rocks in which its lodes occur. These are—granite, gneiss, mica-slate, and a few clay-slates. Tin and wolfram lodes have never been observed in diorite, diabase, sandstone, or limestone. Such kind of negative facts must not be disregarded; this one, for instance, indicates that these lodes are of very remote date, apparently that of the protrusion of the older granite.

The existence of alluvial deposits of tin ore must not be overlooked. These are, in fact, to be regarded as the result of gigantic natural ore washings. The absence of wolframites is probably owing to the more easy mechanical and chemical destruction of these minerals as compared with the tin ore. Even in lodes, instances of the chemical destruction of wolframites, and production of scheelspar, have been observed, unaccompanied by any pseudomorphs after tin ore.

A remarkable feature is presented by the lodes of this formation where they come in contact with those of red hæmatites. It has been observed at Altenberg (Saxony), that at the points of contact both lodes are poorer, and frequently the tin ore is altogether absent.

The lodes of this formation generally possess in a very marked manner the banded structure, especially in the mica slate at Ehrenfriedersdorf (Saxony).

VII. *Clinoedritic lead and zinc formation.*—Under the term clinoedrites, Breithaupt understands a mineralogical genus comprising the various kinds of fahlerz, tennantite, copper-blende, &c.

These minerals are distinguished chemically by their very complicated, although characteristic composition, containing, on the one hand, copper, mercury, silver, zinc, iron, cobalt, and nickel; on the other hand, antimony, arsenic, and tin. All these metals exist as sulphurets; those of copper and mercury with two equivalents to one of sulphur; those of silver, zinc, iron, tin, and probably cobalt and nickel, with equal equivalents; those of antimony and arsenic with two equivalents of metal to three of sulphur.

The clinoedrites occur in very definite paragenetic relations; bournonite is frequently associated with them. In many places this formation occurs alone, sometimes together with the older pyritic, or with the more recent fluo-barytic.

When felspar or iron spar occur in the pyritic lead and zinc formation, it is to be regarded as terminated, and the same may perhaps be said of the second generation of quartz; therefore quartz and iron spar are frequently found to support the clinoedritic formation. Since, however, iron rose and manganese spars possess a close mineralogical relation, and protoxides of iron, manganese, &c., replace each other chemically, they are frequently found alone or associated in the lodes. When pearl spar occurs, it is the oldest of the carbonates. It is remarkable that the galena implanted upon rose spar presents imperfect crystal forms, rounded edges, broken planes, &c. While all these carbonates appear as the supporters of this formation, still they are tolerably contemporaneous in formation with galena, zinc-blende, and the clinoedrites, although these minerals are obviously the more recent, from their distinct superposition. Arsenical pyrites are no longer found, nor indeed in any more recent formation. Magnetic pyrites is likewise wanting. Pyritic minerals, on the whole, are less abundant, and the smaller their quantity the greater the amount of silver in the galena and clinoedrites. When copper pyrites is altogether wanting, weissgültigerz occurs, with thirty-one per cent. of silver. The minerals are likewise more argentiferous when the formation occurs alone, and when the lodes ramify. In this case, even antimonial silver-blende and eugenite occur. When the formation lies over the pyritic, it is poorer in clinoedrites, and the percentage of silver is smaller.

In this formation, as in most others, one or other of its supporting minerals, and sometimes all of them, are wanting, the mineral then being implanted upon the adjoining rock. Sometimes this deficiency is owing to subsequent decomposition, with production of quartz pseudomorphs; thus, at Kapnik the whole of the manganese spar, and at Freiberg the rose spar, have been removed, while the other associated minerals are well preserved.

The formation has sometimes heavy spar superposed, but belonging to more recent formation. At the contact of the clinoedritic with the heavy spar and cœlestine formation, the galena and fahlerz of the former have a large amount of silver.

VIII. *Iron spar formation.*—There are a great number of lodes which consist solely of iron spar and products of its decomposition. When other minerals occur, it is only in a subordinate manner. The most usual associates of iron spar are quartz and felspar, always older; heavy spar always more recent. Examples of the paragenetic relation of these minerals are, however, by no means frequent.

IX. *Copper formation.*—This includes those associations of the more usual sulphurets, without galena and blende, but generally with iron pyrites. There may be several other groups whose relative age is to be determined by future observation. The group here understood is such a one as occurs under circumstances similar to those of the clinoedritic lead and zinc formations. The chief representatives of such a group are—copper pyrites predominating, then sulphuret of copper, variegated pyrites, and clinoedrites. Metallic copper is rare, except in lodes, almost always accompanied by red copper, malachite, and other products of decomposition. It is highly probable that such lodes have been formed by the alteration of sulphurets; and however much the physiognomy of the individual lodes may vary in respect to the cupreous minerals, they were perhaps originally but little or not at all different. The fine modifications of red copper, malachite, and copper lazure at Chessy, near Lyons, have been proved by Fournet to result from the washings of copper pyrites lodes. The same is probably the case with the immense masses of malachite at Nischne Tagilsk and other parts of Siberia.

It has been very generally observed, that cupreous minerals containing oxygen occur at the surface or in the upper parts of the lodes, while at greater depths they consist almost entirely of glance and pyritic minerals. At Bakuranao, in Cuba, malachite and copper lazure have been found, which, when worked to some depth, were found to cover copper pyrites, cuban and magnetic pyrites. Enormous quantities of malachite, tile ore, copper lazure, and metallic copper are obtained from the mines of Burra Burra, which, when further worked, will most probably be found to yield sulphuretted minerals. The metallic copper may very probably have been formed by cementation during the vitriolessence of iron pyrites, and the accompanying copper pyrites, &c., were influenced by this process of decomposition. Perhaps ferruginous minerals acted upon solutions of sulphate of copper during hundreds of centuries, in the same reducing manner as metallic iron acts in a few moments. The natural cupreous springs of Neusohl in Hungary, Altenberg in Saxony, Riotinto near Seville, &c., afford evidence that such processes of vitriolescence still take place in the depth of lodes.

There is in the Wernerian Museum at Freiberg, a fragment of metallic copper, in which a splinter of wood is imbedded, found in "Old Man."* Taking all circumstances into consideration, it is very probable that native metallic copper has been produced by cementation.

The lodes of the copper formation do not often form druses, and the known succession of their minerals presents no great variety. The derivative products are more numerous. Sometimes, however, the cupreous minerals are accumulated in large masses under peculiar conditions of the lodes, for instance at the points of intersection. Uniform distribution of the ores for considerable distances of length and depth is not frequent.

At the mine "Junge Hohe Birke" (Saxony), the copper formation is decidedly more recent than the pyritic lead and zinc, especially in the lodes with a south-westerly direction, and where they intersect vertical lodes, and in these latter, where the former lodes adjoin them. The galena of the old formation, especially in masses with a hexaedral cleavage, is imbedded in copper pyrites, iron pyrites, and sometimes in fahlerz. In one instance, these fragments of galena have been found completely converted into fahlerz, with very considerable diminution of volume, the individual hexaeders obtained by cleavage consisting of a number of small crystals of gray copper united in a divergent manner, so as to form small druses. This pseudomorph is a very remarkable one.

Near Freiberg this formation is represented by coarse

* The technical German term for an old working which has been long abandoned and again resumed.

masses of copper glance, and variegated copper sometimes in the form of galena. The copper glance is both compact and friable, but contains variegated copper, and the whole is covered by quartz. Iron pyrites occur in small hexaedral crystals upon other varieties of copper glance, and porphyritically imbedded in it.

The gray copper occurring in some places contains a good per-centage of silver; but the bournonite associated with it contains very little, and indeed gray copper appears to be poorer in silver when accompanied by bournonite.

It has already been remarked that bismuth glance never occurs without indications of the previous existence of copper pyrites, and the same may be the case with the as yet imperfectly known bismuth, silver, and lead ores which occur at Wolfach in Baden, for the most part disseminated through quartz, and accompanied by copper pyrites, heavy spar, fluor spar, &c.

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*The Ocean—its Currents, Tides, Depth, and the Outlines of its Bottom.**

When, a short time ago, I was conversing upon comparative or ancient geography with a friend whose mind ranges over all subjects, from the epic to the abstrusest mathematical problem, I was reminded by him that those who are acquainted with the writings of the ancients would see with admiration how often a piece of knowledge, or a thought belonging to those bygone days, emerges with an applicability to our new geographical views which is truly astounding. Take, says he, the Homeric view of the ocean; it was an ocean, and yet an *ocean stream.* It covered the immeasurable earth, and yet it ran round the boundaries of all known lands. Thus, the most learned of our popular poets has also spoken of the region

"Where jealous Ocean, that old river, winds
His far extended arms, till with deep fall
Half his waste flood the large Atlantique fills."

When the poet goes on to pour his flood into

"Slow, unfathom'd Stygian pool,"

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* From Sir R. I. Murchison's Address at the Anniversary Meeting of the Royal Geographical Society, 23d May 1853.

we have only to vary the reading, as Dr Whewell suggests, to

"Half the broad Pacific's tideless pool."*

But the point for us is not merely to occupy ourselves with finding that the ocean, as the ancients imagined, does "wind its extended arms" like those of a river. However we may regard this as a flight of imagination, or admire it as the foreknowledge of our ancestors, our duty is more stern, and we must pass from the myth, to ascertain what arms this jealous ocean has, how far they extend, where they wind, and where they end in "steep fall;" which last words, brought down to our geographical prose, means merely an accelerated current. Now, although we have had many admirable contributions to answer these questions, and above all comparison those of the illustrious Rennel, who led the way in all these inquiries, there still remained a vast deal to be accomplished. The memoir of Mr Findlay, recently read before the Society, illustrated as it was by a series of admirably constructed large charts, in which all the cold or polar currents were marked in a blue colour, and the warm currents in a red tint, is certainly the most complete general view which has been taken in our day of this grand subject —a full and accurate acquaintance with which is of such importance in the intercourse between distant nations. In these valuable documents, and particularly in the work of the same author to which I called your attention last year, we not only see the extent of our present knowledge as to the nature and distinction of upper and under currents, but also the desiderata which remain to be filled up. I cannot here, indeed, attempt to convey to you an adequate view of Mr Findlay's labours of compilation and deduction, and must restrict myself to saying that, taking into account the known currents of the Atlantic and Pacific, and having regard to

* Though there are many tides in the Pacific, this idea of a tideless pool may be correctly applied to the central Pacific around Tahiti. Geographers will do well to refer to the Appendix to Captain Fitzroy's second volume of the Surveying Voyages of the Adventure and Beagle, to see the value attached by that successful navigator to the essays of Dr Whewell, and also to appreciate the importance of the views of so experienced and scientific a seaman.

additional observations, he reduces the motions of each of the two oceans to systems of revolving, re-entering currents; one such circle, or orbit, existing in each case to the north and south of the equator.

The currents of the ocean are so complex and numerous, that it is not to be expected we can obtain all the requisite materials to form a correct view from ordinary navigators who are occupied in trade and commerce. And this brings me back to a point on which I dwelt last year:—or an expedition *ad hoc*, and entirely devoted to the survey of the *Tides of the Ocean*. Such an expedition, connected as it must be with a special attention to the currents, would, I repeat, be truly worthy of this maritime nation, and all geographers would rejoice if its conduct were confided to our associate Captain Fitzroy, whose tried capacity as a naval surveyor and sound nautical accomplishments particularly qualify him for such an employment. For we must recollect, that in addition to the researches of Sir John Lubbock in this country, and those of Professor Bache in the United States, the able, consecutive, and elaborate investigations of Dr Whewell, founded on real data, have led far towards the establishment of definite laws respecting the tides. It is therefore much to be desired that the naval authorities of Great Britain, honouring these skilful gratuitous labours, should without delay accede to the prayer of the British Association, and send out such an expedition as is here proposed—one which would enable Dr Whewell to complete a generalization worthy of this age of inquiry, and of the greatest utility to navigation.

In the meantime it is a subject of congratulation that a peer of the realm distinguished for his acquirements in astronomical science, sustaining the same objects for which we are contending in common with the British Association and the Royal Society, should have brought this important subject before Parliament, directing specially the attention of the Upper House to the very great importance of such observations and generalizations as those of Lieut. Maury of the United States Navy. This meritorious officer, some of whose researches were adverted to by my predecessor, has recently issued a circular which calls for the co-operation of the principal maritime nations in collecting materials for wind and current charts. The prayer of the British Association for the Advancement of Science, and of the Royal Society, that a more extended and systematic direction be given to meteorological observations at sea, as prepared by Lieut. Maury, will, I trust, meet with favour in the eyes of the British Government. The Royal Society says truly, that, short as the time is that the system has been in operation, the results to which it has led are of very great importance to the interests of navigation and commerce; and it is earnestly to be hoped that the system of co-operative observation may be zealously promoted. In short, when Lord Wrottesley explained in Parliament what enormous spaces of the ocean were still blanks as to any records of the winds, or of the currents and temperatures of the sea, the words which he added will find a response in the breasts of all whom I now address:—"That these blank spaces are a reproach to the civilization of the present age; that it is our duty not to rest satisfied until we know all that can be known about the globe we inhabit that can be rendered in any way profitable to our common species; and that, therefore, the principal maritime nations should share the labour of exploring these vacant spaces."

Our neighbours the French* have indeed shewn their desire to promote useful surveys of distant seas by the addition they have recently made to our knowledge of the hydrography of the Chinese seas, resulting from the researches of the "Capricieuse" corvette, under the command of Captain Roquemaurel, who has trigonometrically surveyed the eastern coast of Corea and Chinese Tartary for an extent of 130 leagues. One of the results is the ascertainment of an excellent port in the Golfe d'Anville, nearly in the same parallel as the strait of Matsmai, from which it is about 130 leagues distant; parallels in which it is suggested some profitable whale-fishing grounds may also be met with.

* Since our last anniversary the Meteorological Society of Paris has been established, and is now organized in so satisfactory a manner, that I have joined it myself, and trust that many of my countrymen may do so likewise.

As the phenomena of tides, currents, winds, and the condition of the atmosphere and ocean are in great measure dependent on the outline of the solid portion of the earth, so has this year brought with it the most remarkable hydrographical observation of modern times, in the detection of an abyss in the ocean said to be nearly double the depth of any of which we previously had a conception.

Hitherto, indeed, it had been the prevalent belief (an opinion supported by Laplace himself), that the depressions of the crust beneath the ocean were probably of about the same extent as the elevations above the sea. Some observations of our scientific associate, Captain Denham, R.N., have, however, gone far to modify if not to set aside this hypothesis. By soundings* in the ocean, midway between the Cape of Good Hope and Tristan d'Acunha, he has concluded, after several times dropping the plummet, and by finding the line always stop at the same point, that the sea has there the enormous depth of 7706 fathoms, or double the height of Chimborazo, the giant of the Andes.

It is also a triumph of nautical skill and perseverance that the "Herald," and her companion the "Torch" steamer, should have been enabled to lie at anchor more than three weeks on the comparatively shallower banks in the middle of the wide Atlantic ocean, such a position having greatly astonished those mariners whose course happened to cross these new and unheard-of anchoring grounds. When so stationed Captain Denham further ascertained, by sending down thermometers, that, whilst the surface-water was at 90°, the cold never exceeded 40° at any depths which were sounded. In addition to important magnetical observations, he has excited great interest amongst geologists by proving, that, within one cast of the lead, coral reefs rise suddenly like a wall, from *no bottom* at 200 fathoms to 19 fathoms

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* The soundings were made with peculiar lines given to him by Commodore M'Keever of the United States Navy. But I must state that some naval surveyors are of opinion, that the results may have been more or less deceptive, in consequence of the line not lying in a straight direction between the ship and the plummet, whether by the vessel drifting during so long an operation, or by the influence of currents and other causes.

from the surface; thus illustrating one of the phenomena on which Mr C. Darwin has thrown so much light.

In looking at the statement of Captain Denham, and at the vast number of desiderata that remain to be inquired into, it is not, therefore, too much to affirm, that until our submarine knowledge shall have been vastly more extended than it is; until, in short, we know as much of the earth beneath the waters as of that which is above them, we are wanting in several of the most essential elements to explain the proximate causes of the deflection of the great oceanic currents to which we have been adverting, as well as of the origin of many climatal peculiarities.

The geologist, meteorologist, and geographer, are indeed each of them equally interested in the determination of grand problems like these, which will teach us the forms of the submerged lands around which run the various streams delineated in the maps of Mr Findlay: such, for example, as that which, with its superjacent floating masses of "Sargasso," or sea-weed, circles in the North Atlantic, or the great whaling grounds of the North Pacific, around which the North Equatorial and Japanese currents flow; or, again, that mass between New Zealand and Australia which is encircled by the Australian current.

In this last instance the geologist again steps in to help to solve the problem. The discovery of the enormous bird, the Dinornis, in the comparatively small tract of New Zealand, has naturally led him to suppose that there was once a much larger adjacent mass of land to provide for the sustenance of such huge creatures; and hence it is a fair inference, that the nucleus around which the Australian current runs, is the central and higher portion of what was a large continent once united with New Zealand.*

In the meantime, passing from such theoretical views, I

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* The same reasoning may be applied to the island of Madagascar, where eggs of birds have been found, which contain the substance of 240 hen eggs. This isle may be the remnant of a former vast Eastern continent now submerged. See Professor Edward Forbes's proofs of the existence of such ancient continents, derived from the present insulation of certain groups of plants and animals.—*Memoirs Geol. Surv.*, vol. i.

seize on the one great submarine phenomenon indicated by Captain Denham, to assure you that however it may be modified, I view it as of singular importance in enabling naturalists to account for the marked separation of the tribes of marine beings which at present exist in regions widely separated from each others. For vast depths are to many inhabitants of the sea (including all the mollusca) what great and snowy heights are to the animals of the land—perfectly impassable barriers. Now, whilst we have in the profundity of parts of the present ocean a distinct reason for the separation of aquatic races in our times, the near approach, on the contrary, to a general and uniform distribution of marine mollusca in primeval periods, as registered in the ancient sea bottoms which have been raised to form our present continents, compels me to believe that the earlier geographical outlines of our planet were infinitely more simple than the present. In other words, that the oceans were then broader on the whole, the lands of less altitude, and the cavities in the sea bottom by no means so deep as those of our actual highly diversified outlines. For, had such very varied outlines prevailed in primeval periods, most unquestionably the same land-plants which are found in the old coal formation could not have lived from Spitzbergen and the Polar regions to temperate and even warm latitudes, and in nearly all longitudes; nor could the same tribes, and often the small species of shells and other animals, have inhabited the most distant seas at the same period.

It is this varied outline, as brought about after many revolutions and changes of the crust of the globe, which presents to the meteorologist that mass of complicated problems, so few of which have yet been sufficiently solved to enable us to arrive at definite laws respecting weather, or the causes of its seemingly capricious changes. But still, notwithstanding all its variations, there is a mean distribution of heat and cold which restricts certain groups of creatures to each continent and sea; and the more we can approach to a correct delineation of these zones beneath the waters, as well as those above them, and comprehend the nature of all tides and currents, the more perfectly shall we attain some of the highest aims of the physical geographer.

On Some Points in the Physical Geography of Norway, chiefly connected with its Snow-Fields and Glaciers. By Professor JAMES FORBES, D.C.L., F.R.S., Sec. R.S. Ed., Corresponding Member of the Institute of France.

[We insert the *ninth* chapter of an admirable work that has just appeared from the pen of Professor James D. Forbes, on Norway and its Glaciers, visited in 1851—followed by Journals of Excursions in the High Alps of Dauphiné, Berne, and Savoy. This invaluable work, so deeply interesting and important, reflects great honour on our distinguished friend, and shews his usual profound knowledge of the various subjects treated of, and is a valuable addition to the scientific world. It ought to be carefully studied by every traveller.]

Introductory Remarks. § 1. *On the Configuration of Norway—Its Ground Plan—Its Mountainous Districts or Fields are usually Plateaux—Large proportion of elevated Area—The Kjölen Mountains—their existence denied by some Geographers—Three Sections of Norway.* § 2. *On some peculiarities of the Climate of Norway—Less severe than commonly supposed, or than any other land in the same parallel—The causes of this—The Summer and Winter curves of equal temperature—Contrast of the two sides of the Peninsula.* § 3. *On the position of the Snow-line in Norway—Mainly determined by the Summer temperature—Particulars of observations on the subject—Of the limit of growth of the Birch—Influence of the Sea in depressing the Snow-line—Table of Results.*

Amongst the many questions with which a stray traveller is sure to be addressed by the peasantry of a remote country, one of the most puzzling to answer is, as to the pleasure or information he can find in looking at *their* hills and waters, and woods and snows. Has he not enough of such things at home? What value have stones and plants, which lie utterly concealed from the eyes of the inhabitants to whom they belong, but which can tempt the wealthy stranger to lose his time, his money, and his comfort, in examining, perhaps in collecting them.* The naturalness of

* The inability of the peasantry to ascribe any other motive than interest or compulsion to such journeys, is amusingly experienced by every traveller off

the inquiry, the reality of the paradox, makes the answer often difficult. There are very many persons of opportunities far superior to these poor peasants who can form nearly as little idea of the motives for such toilsome journeys. To them, the country is the country everywhere, its stones are stones merely, its glaciers and its lakes are *accidents*, which suggest no particular conclusions except as they give a momentary variety to the landscape, or as they affect the value of the soil.

What comparative anatomy is to the study of living beings, physical geography, or the comparison of different countries, is to the study of the earth we live on. The interest of each part is beyond measure increased by comparing it with other parts; and the more such comparisons we are enabled to make, the more distinct meaning can we attach to even a few slight and seemingly isolated observations in a country wholly new to us, as when Owen reproduces the skeleton of a long extinct bird from a few imperfect bones brought from the antipodes.

To construct the orographical map (map of mountainous regions) or skeleton of a country, is a more difficult task than it might at first appear to be. The materials for a complete *relief* or model exist for but a few limited portions of the globe. The materials for maps are gathered from comparatively limited observation. The *tact* necessary for per-

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the beaten tracks, in the theories which are formed as to his vocation. This is nowhere the case more than in the more secluded parts of France. I once amused myself by reckoning up the conjectures as to my business, and the motives ascribed to me, during a journey of no very great extent, which included, as well as I recollect, the following, besides guesses nearer the mark:—An engineer of mines, a Government surveyor, a *garde forestier*, a tax-gatherer, the descendant of a confiscated noble of the first revolution surveying his paternal acres, a criminal escaping by bypaths from justice, an iron-merchant, a stone-mason, and a gold-finder. Of these various *aliases*, the last is probably the most inconvenient. I recollect travelling through the mountains of Cogne with a half-witted fellow, a sort of crétin, for a guide, who, after hearing all the explanations I had to give of my journey, constantly returned with a malicious leer to the loss the country suffered by ignorance of the treasure which lay about in it, *particularly under the glaciers*, and which more knowing strangers, assisted, he insinuated, by mystic arts, could turn to an excellent profit.

ceiving the peculiarities of the configuration of a country is only to be acquired by practice; and when acquired, it leads to skilful and interesting generalization. A general commanding an army, a geologist exploring a district, and a fox-hunter pursuing his sport, each in their way acquire a facility analogous to that of the comparative anatomist just referred to, in apprehending the whole from a part, in predicting what will be the probable course of a mountain ridge, or of a river which he has not yet seen, and in finding a practicable passage across an intricate and difficult country, by which even a native might be bewildered. Since then even the mere base or skeleton of a country possesses so much distinctive character, and offers so many subjects of interesting contrast and comparison, it is very obvious that the details of structure, as well as of the various plants which embellish it, animals which live upon, as well as rational beings which people it, with their peculiarities of occupation, habits and dress, furnish an exhaustless field, in which the most restless curiosity may expatiate. But to explain all these sources of interest to the more ignorant class of peasantry is impossible, though here and there intelligent men may be found, even in the humblest class, and in all countries, who possess that spark of divine mind which only requires to be roused, and which sometimes unexpectedly responds to the well-meant effort of the traveller to enlighten him as to his occupations and interest.

The only part of the physical geography of Norway of which I intend here to offer the slightest sketch, is what regards the distribution of perpetual snow and of glaciers, being the objects of my chief observations recorded in the preceding pages. A comparison in this respect with the Alps offers much interest, and though my contribution may be slight and inconsiderable, it will, I am persuaded, lead the way to systematic inquiry by those more favourably placed for pursuing it. Norway itself assuredly does not want for persons thoroughly qualified to obtain and make use of the information thus desired.

The existence of perpetual snow, the elevation at which it begins above the sea level, and the formation of glaciers depending for their origin and nutrition upon these snow-beds, are complicated phenomena, referable by analysis to a variety of causes or conditions. Of these, the most important are the configuration of the soil and the climate, which last is itself a complex and somewhat undefined fact.

I shall, for greater distinctness, reduce my remarks to different heads; and under some of these I shall endeavour to classify several of the facts incidentally referred to in the previous chapters.

§ 1. *On the Configuration of Norway.*

As there are few parts of the world where snow lies in summer at the level of the sea, the existence of perpetual snow depends in Norway, as elsewhere, upon the greater or less elevation of the mountains. The general height of mountains in Scandinavia is inferior to that of the Alps, Andes, Caucasus, or Himalaya, and is therefore so far in accordance with the generally received opinion, that the elevation of the land diminishes from the equator towards either pole. The highest ground in Norway is 8500 feet above the sea level, in latitude $61\frac{1}{2}°$; but whilst the country is justly accounted a mountainous one, it is so rather in respect of its general elevation than from the conspicuousness of its isolated summits. Sweden is comparatively low and tame; Norway defends it, like a huge breakwater, from the invasion of the North Sea, whose force is indeed still tremendous, but which, from the traces of former convulsions, would appear to have been the seat of powers still more energetic. The ragged outline of the coast, the depth of its inlets or fiords, the boldness of its headlands, the multitude of its islands, often almost undistinguishable from the mainland, are facts familiarly known. They seem to shew that the boundary of sea and land has been decided only after a prolonged struggle, and that great masses of the latter have gradually been undermined or abraded, so that a tolerably permanent condition has only been obtained when, after the crumbling of lesser obstacles, the mountains themselves have become the buttresses of Scandinavia.

The configuration of Norway may be conveniently considered in two portions; the comparatively narrow district, extending from near Throndhjem to the North Cape, a distance of above 600 English miles, and the more expanded part, 400 miles in its greatest dimension, from Throndhjem to the Naes of Norway. Throughout the former, the mountains cling, as it were, to the coast, and the boundary between Sweden and Norway is only one-fourth of the breadth of the peninsula distant from the North Sea, which yet includes all the more considerable elevations. South of the Syl-field (lat. 63°) the high ground occupies by far the greater part of the breadth of Norway in its widest extension, and fully half the breadth of the peninsula in the parallel of the Dovre-field. This is due chiefly to the expansion of the coast to the westward, where mountains of enduring crystalline rocks form that prodigious *lobe* of land dividing the North Sea form the Skagerack, which, bearing the whole brunt of forces which appear to have come from the north, not only defended the entire north of Europe from the shock, but probably furnished by their attrition the material of which the low grounds of the continent of Europe are mainly composed.

In this general disposition of the mountainous masses of Norway we see a strong analogy to the west coasts of our islands, and likewise to those of North and South America. It appears almost certain that a common cause has devastated the western shores of nearly every continent.

The forms of the Norwegian mountains have been very generally mistaken by geographers. They do not constitute either unbroken chains rising from the low grounds and forming a ridge, nor are they a series of distinct detached elevations, but, in the southern division of the country especially, they form *plateaux* or table-lands of great breadth, and generally more or less connected together, though occasionally separated by deep but always narrow valleys. In the description of the view from Sneehättan I have endeavoured to convey a clear idea of these wonderful expansions of mountains, often so level, that upon what may almost be called their *summits*, a coach and four might be driven along or across them for many many miles, did roads exist, and across which the eye wanders for immense distances, overlooking entirely the valleys, which are concealed by their narrowness, and interrupted only by undulations of ground, or by small mountains which rise here and there with comparatively little picturesque effect above the general level.

These table-topped mountains are the *Fields*, or more properly the *Fjelds*, of Norway, which, in their less interrupted or more elevated parts, have acquired specific names. They have been very erroneously supposed by map-makers to form a continued ridge serpentining through the country, though preserving a general parallelism to the coast, of which the chief (from north to south) are the Dovre-field, the Lange-field, the Sogne-field, the Fille-field, and the Hardanger-field.

The error in question is easily traced to the usual method of constructing a map from rude and imperfect observations. The river-courses are first determined with a certain accuracy,* and from analogy (rather a precarious one, however) with other countries, the origin of these is traced to a *water-shed* or ridge, assumed to be comparatively narrow, along which the chief summits are to be sought, and supposed to be extended merely by *spurs* or lateral ranges of small extent between the valleys. To such a theory the construction of the common maps of Norway may be easily traced, and the *tradition* of this unbroken chain may be found in nearly every map.

Thus, the general surface of the country is in reality composed of elevated and barren table-lands. The proportion of arable land (land which *might* be tilled), to the entire extent of Norway, is not, according to the competent authority of Professor Munch, more than 1 to 10; and if we exclude a few local enlargments of the plains near the capitals, it would not even exceed 1 to 100. By a rude estimation on Professor

* The river-courses preserve a surprisingly exact parallelism on the south-eastern slope of the peninsula from the Skagerack to near the head of the Gulf of Bothnia. The direction of these lines of fissure is about 30° with the meridian in Southern Norway, but above 40° in Lapland. In neither case, probably, does it coincide with the direction of greatest declivity of the general surface of the continent.

Kielhau's map, I find that the portion of the surface of Norway, south of the Throndhjem-fiord, which *exceeds* 3000 feet above the sea, amounts to very nearly 40 per cent. of the whole; and when it is recollected that only one summit exceeds 8000 feet, and that the spaces exceeding 6000 are almost inappreciable on the map, it will be more clearly understood how completely the mountains have the character of table-lands, whose average height probably rather falls short of than exceeds 4000 feet.*

The centre of gravity of the elevated country preserves a rough parallelism to the coast, although from the prodigious indentations made by the larger fiords, the bases of the higher mountains are often washed by salt or at least brackish water. Of the outlying portions which approach nearest to the sea, the most remarkable are the mountains of Justedal and the Folgefond, both of which are covered with perpetual snow.

In the northern district of Scandinavia, where the theory of a ridge is in some respects less inaccurate than in the south, its insufficiency was clearly discovered by the difficulty or impossibility of defining the line of demarcation between Norway and Sweden by that of a continuous water-shed. Such a ridge, if it exist at all, must be held in some cases to run up to the very coast of Norway, or even beyond it into the islands; in other places it dies out altogether, and is resumed with a change of direction.† The present boundary between Norway and Sweden was defined by a joint commission of engineers in the middle of the last century, and is represented on nearly every map as the exact direction of a slightly zigzag chain of mountains called the Kjölen or Kœlen. This is assumed, in most maps, to be prolonged

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* These estimates refer to German or Rhenish feet, which are about 3 per cent. longer than English.

† Pontoppidan was not unaware of this, for he states, that in Finmark the Kœlen ridge in many places breaks into large valleys, and consequently is not so continued as farther towards the south, and that it seldom reaches above four leagues in a continued chain. (*Nat. Hist. of Norway*, i., 40.) The worthy Bishop of Bergen, though not unjustly accused of credulity, was evidently well read in the science of his time in several departments.

along the border of the two countries, considerably to the south-east of Throndhjem, and it was even long maintained that a mountain mass existed there of prodigious elevation, from which a great many rivers, particularly the Glommen, the Göta, and the Dal, take their rise. The height of this fabulous mountain was even assumed to be 12,000 feet. It is, however, only a slight and lower extension of the plateau of the Dovre-field beyond the deep valley of the Glommen, and its greatest height does not amount to 5000 feet.

Perhaps, however, those Scandinavian geographers go too far who insist that the existence of the Kjölen is purely *mythical*, and that they must be "hunted and expelled" from our maps. The able researches of Wahlenberg, Keilhau, Vibe, and Munch, and the improved charts of the coast, have thrown the greatest light on the form of the country. The *contoured* map of Keilhau, though, of course, in many places conjectural, gives us a tolerably accurate picture of the general relief; and though the Kjölen range be broken, sometimes almost annihilated, now pushed inland, and now bounding the very shore (as at Fondal, lat. 66½°, and Lyngen, lat. 70°), it must, I think, be admitted, that it is worthy of being classed amongst mountain ranges.* It has not in the far north the peculiarly tabular form of the southern mountains, and is distinguished by many summits of noble forms, and a grandeur disproportioned to their absolute elevation, as the Seven Sisters, the Lofoddens, and the Peppertinderne. It attains its greatest elevation (I speak now of the northern division) at Sulitelma, in lat. 67½°, being no less than 6200 English feet. Sulitelma is not an isolated mountain, but forms part of a wild and extensive group, first visited and clearly described by Wahlenberg, who justly characterizes it as the centre of the Alps of Lapland.

It is true that there are at intervals passes across the Kjölen mountains, which are extremely low, such as the frequented road from Throndhjem to Sundsvall on the Baltic,

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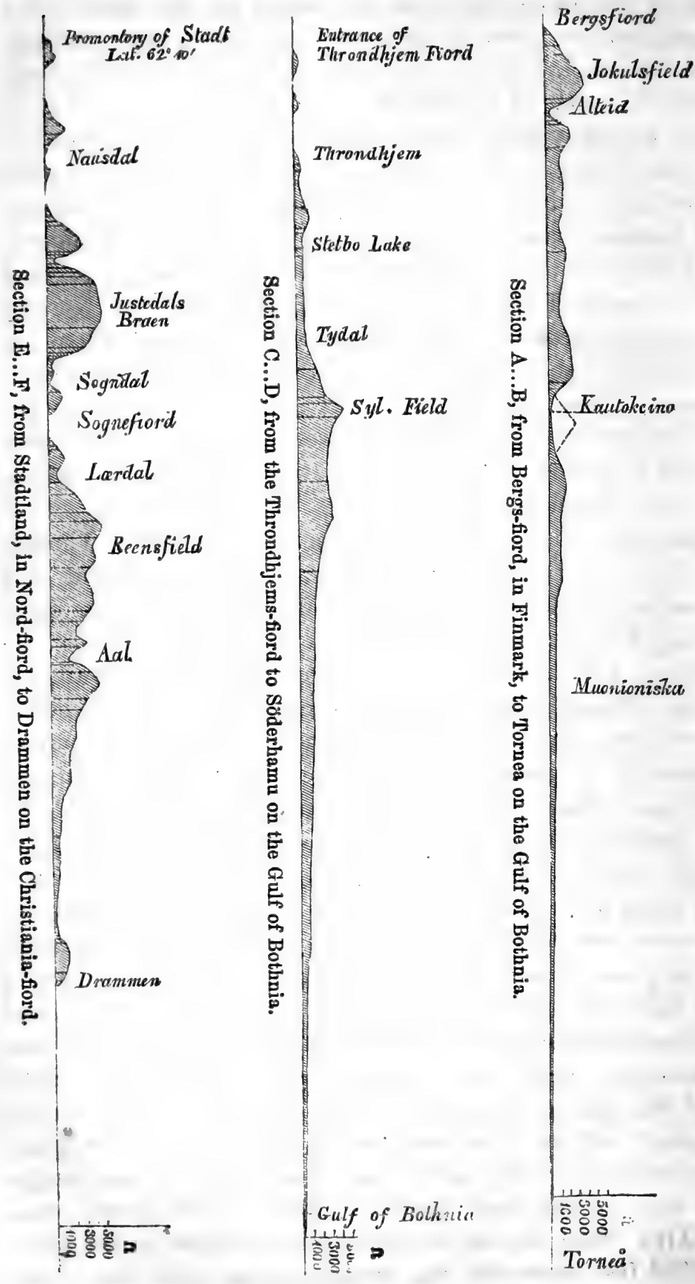
* Wahlenberg, surely a most competent authority, continually speaks of the "alpium jugum" in describing the course of the mountains between Norway and Sweden.

the ascent of which is everywhere easy, and which attains a height of only 2000 feet above the sea. About lat. 64°·3, there appears to be a distinct depression in the chain, near the Namsen river. In lat. 68°·3, which is that of the Lofoddens, there is a pass across the peninsula by the lake of the Tornea Trask, which is elevated no more than 1300 French feet, whilst the well-known track from Alten to the head of the Gulf of Bothnia, by Kautokeino, does not exceed 864 French feet, according to Von Buch, and beyond this the mountains never resume their continuity. A detached summit (Rastekaise) reaches 2700 feet; the North Cape itself (on the island of Mageroe) attains little more than 900 feet. From this point eastwards the country becomes tame and level, nor do the northern parts of Russia or Siberia offer, probably, any considerable elevations, with the exception of the more depressed part of the chain of Oural.

That the elevation of the Kjölen mountains is the result of forces exerted parallel to an ideal axis, is illustrated by the general uniformity of the declivity on the side of Lapland. A very remarkable chain of lakes, one or more of which occur upon almost every river emptying itself into the Bothnian Gulf, and nearly equidistant from the coast, at a level also tolerably uniform, it is believed, at from 1200 to 1500 feet, point out a symmetry in the fall of the ground throughout nearly the whole extent of the peninsula.

The map which accompanies this work, though on a small scale, has been coustructed with great care, from a variety of authorities, principally Norwegian. An attempt has been made to represent the elevated plateaux which constitute the high land of Norway, and to annihilate that stiff ridge of mountains which figure in almost every map from the Lindesnæs to the North Cape.

I close these remarks by referring to three sections which I have carefully made from the best data I could find, and chiefly from the map of Keilhau already referred to, shewing the transverse section of Scandinavia at three characteristic places—the first or most northern (corresponding to the line A B on the general map) is from the Bergs-fiord, in lat. 70·2°, to Tornea, at the head of the Gulf of Bothnia. Here the


Promontory of Stadt
Lat. 62° 10′
Nausdal
Justedals Braen
Sogndal
Sognefiord
Lærdal
Reensfield
Aal
Drammen
Section E...F, from Stadtland, in Nord-fiord, to Drammen on the Christiania-fiord.
Entrance of Throndhjem Fiord
Throndhjem
Stetbo Lake
Tydal
Syl. Field
Gulf of Bothnia
Section C...D, from the Throndhjems-fiord to Söderhamu on the Gulf of Bothnia.
Bergsfiord
Jokulsfield
Alteid
Kautokeino
Muonioniska
Torneå
Section A...B, from Bergs-fiord, in Finmark, to Tornea on the Gulf of Bothnia.

axis of the range has entirely passed to the coast. The second section (from C to D on the map) passes through Throndhjem and part of the Syl-field to the Gulf of Bothnia, about 2° north of Stockholm. The third section, E F, is made to pass through some of the most elevated ground in Southern Norway, including the Justedal mountains and the Fille-field. It begins at the conspicuous headland of Stadt, on the western coast (lat. 62° 10′), and terminates at Drammen, on a branch of the Christania-fiord, being very nearly parallel to the marked direction of the river-courses of Norway already referred to. In all these sections the elevations are to the horizontal measures in the proportion of about *thirteen to one*. These are all *prominent* sections. They shew the character of the elevations when well developed. That there should be profound valleys intersecting the mountain ranges, or even occasional discontinuities, cannot fairly be urged against the existence of mountain chains altogether. Though the boundary of Sweden and Norway be often fanciful, and the maps founded on its supposed physical meaning be egregiously wrong, a certain continuity of elevation is still to be observed. And, indeed, the same error which has prevailed in maps of Scandinavia, applies in a measure to those of better known countries. The construction of maps by river-courses instead of by lines of elevation is general; and geologists are well aware that even the chain of Alps, which is remarkable for its continuity, is arranged in groups rather than in a defined ridge. Many of the passes seem to let the traveller through the chain as it were by stealth, and really mark the boundary between two conterminous *blocks* of mountains, or *massifs*, as they are termed by foreign writers. Such is the pass of the Little St Bernard, as well as the Col de la Seigne, and still more strikingly that of the Finstermunz in Tyrol (Reschen Scheideck, 4600 feet), between the huge Oertler Spitz and the glacial mountains of the Oetzthal. Some of the highest and most imposing summits, instead of occupying the crown of the ridge, are found in lateral subordinate ranges, or even in the mere spurs or offsets of the great chain of Alps. Such are the *massifs* of Mont Pelvoux in Dauphiné, 13,500 feet above the sea, communicating with the Cottian

Alps by the Col de Lauteret, which is only 6700. Such the entire range of the Bernese Oberland, whose culminating point is 14,100 feet, and whose isthmus is the Grimsel (7200 feet); and such the majestic summit ofMischabelhörner, forming a mere outline of Monte Rosa, between the narrow valleys of Saas and Zermatt, which, though almost unseen by tourists, are giants of the second class. Dr Thomson, in his lately published and curious work on the Himalaya, justly remarks that the universal notion of parallel and continuous mountain ranges is, to a great extent, a delusion of perspective.

Ordnance Survey of Scotland.

We insert for our readers a very valuable table, containing an abstract of replies to the Treasury respecting the scales for the Ordnance Survey, presented to both Houses of Parliament by command of Her Majesty. In this important table will be found the names of the individuals who approve of the different scales, such as the Lord Advocate of Scotland, Members of Parliament, Provosts of Cities, Commissioners of Supply, County Gentlemen, Presidents of Societies, Engineers, Directors of Surveys, Land-Agents, &c. &c. We append to the tables a summary of the whole for rural districts and for towns.

It will be seen from Sir Charles Trevelyan's letter that the undermentioned table was drawn up from a series of documents sent to the Treasury by the different individuals mentioned in the table. The whole of this correspondence between the Treasury and Ordnance in 1840, and the replies to the Treasury circular, in favour of the six-inch scale and of other scales, has been printed by Government.

Letter from the Treasury transmitting the foregoing Correspondence.

"Treasury Chambers, *April* 16, 1853.

"The accompanying correspondence and memoranda describe—first, the grounds upon which it was determined, in 1840, to publish the Ordnance map on the scale of six inches to the mile for the country, and five feet to the mile for towns; and, secondly, the opinions now given on the question, whether the purposes which a national survey ought to subserve would be more fully provided for by an increased scale; and how far such increased scale would involve increased expense.

"The Lords Commissioners of Her Majesty's Treasury request that after having attentively read these papers, you will state, in the annexed form, what scales you would recommend for any national surveys which may henceforward be carried on at the public expense; and that you will add any special observations you may have to make in support of your opinions.

"It is assumed that the results of the Ordnance Survey will, under any circumstances, be separately published on the reduced scale of one inch to the mile; and the question upon which an opinion is solicited is merely between the scale of six inches and any larger scale.

(Signed) C. E. TREVELYAN."

Abstract of the Replies to the Treasury Circular, 16*th April* 1853.

1.—In favour of the Six-inch Scale.

2.—In favour of other Scales.

1. *In favour of the Six-inch Scale.*

No. in Series.	Treasury Register Number.	Date.	Party replying.	Scale recommended. Rural Districts. Draft.	Rural Districts. Engraved.	Towns. Draft.	Towns. Engraved.
		1853.		Inches to a Mile.			
1	8,946	May 2	Hon. T. F. Kennedy, Commissioner of Woods, &c.	6	6*a*	60	...
2	8,947	... ...	Mr A. Keith Johnston	6	1	...	...
3	9,119	... 4	Vice-Chancellor Stuart	6	1	...	...
4	9,304	... 6	Commissioners of Supply, Clackmannanshire	6	6	...	...
5	9,412	... 7	Secretary to Society of Arts,	6	6	60	60
6	9,423	... ...	Messrs Stewart and Kincaid,	(6 or 8)		(60 or 80)	
7	9,426	... ...	Com. of Supply, Banffshire	6	...	60	...
8	9,542	... 9	Com. of Supply, Elgin,	6	1	...	...
9	9,543	... ...	Com. of Supply, Stirling,	6	6	120	60
10	9,547	... ...	Com. of Supply, Ross-shire	6	...	...	...
11	9,548	... ...	Com. of Supply, Caithness	6*b*	1*b*	60*b*	6*b*
12	9,594	... 10	Mr William Shadwell Milne	6	...	60	...
13	9,595	... ...	Mr Charles Rowcliffe	6	1	60	10

(*a*) Erroneously printed 1 in the Parliamentary Paper. (*b*) "Not less than."

No. in Series.	Treasury Register Number.	Date.	Party replying.	Scale recommended.			
				Rural Districts.		Towns.	
				Draft.	Engraved.	Draft.	Engraved.
		1853.		Inches to a Mile			
14	9,805	May 12	Mr James M. Rendel	6	1	(*a*)	...
15	9,830	... ...	Sir Philip Egerton, M.P.	6	1	...	...
16	9,900	... 13	The Lord Provost of Edinburgh	6	6	60	60
17	10,084	... ...	Sir James Matheson, Bart., M.P.	6	1	120	...
18	10,344	... 19	The Principal of Glasgow College	6	1	24	12
19	10,565	... 21	Admiral Sir F. Beaufort, Hydrographer	...	6	...	...
20	10,568	... ...	Com. of Supply, Zetland	6	..	60	...
21	10,608	... ...	Town-Council of Perth	6	...	60	...
22	10,655	... 23	Professor Forbes	6	1	...	...
23	10,890	... 27	Mr David Stevenson	...	6	...	...
24	11,488	June 3	The Deputy Clerk-Register	6	...	60	...
25	12,917	... 23	Com. of Supply, Buteshire	6	6	...	...
26	14,064	July 8	Mr G. B. Greenough	6	6	...	...
27	15,251	... 25	Sir Denham Norreys, Bart., M.P.	6	...	132	...
28	17,693	Aug. 27	Mr A. Hunter	6	6	120	60
29	17,960	... 31	Mr J. F. Bateman	6	6	60	60
30	17,961	... ...	The Provost of Wigtown	6	1	60	60
31	18,129	Sept. 2	Mr John Dickson	6	6	60	60
32	19,711	... 30	Mr William Fairbairn	6	6	60	60

2. *In favour of other Scales.*

No. in Series.	Treasury Register Number.	Date.	Party replying.	Rural Draft.	Rural Engraved.	Towns Draft.	Towns Engraved.
		1853.					
1	8,548	Apr. 26	The Registrar-General	24	12	120	60
2	8,562	... ...	President of the Geographical Soc.	24	12	...	...
3	8,567	... ...	Mr H. Bellenden Ker	(*b*)	6	(*b*	60
4	8,732	... 28	Lord Beaumont	26⅔	12	(*c*)	60
5	8,736	... ...	Mr A. Dunlop, M.P.	24	12	120	120
6	8,737	... ...	Mr E. Ellice, jun., M.P.	26	1	...	...
7	8,811	... 29	Copyhold, Inclosure, and Tithe Commissioners	26⅔	26⅔	120	...
8	8,948	May 2	Mr G. S. Duff, M.P.	24	12	120	60
9	8,949	... ...	Mr Richard Hall, Land-Agent	20	10	80	40
10	8,950	... ...	Mr J. Lancaster, Land-Agent	24	6	120	60
11	9,001	... 3	Com. of Supply, Kirkcudbright	12	6	120	60
12	9,002	... ...	Rev. R. Jones, Cathedral Commission	26⅔	26⅔	...	...
13	9,003	... ...	Com. of Supply, Aberdeenshire	24	6	120	60
14	9,079	... 4	Mr J. Duff. M.P.	24	12	120	60
15	9,115	... ...	Mr J. M. Herbert, Judge of County Court	24	12	120	60
16	9,116	... ...	Com. of Supply, County of Lanark	24	12	...	...
17	9,118	.. ...	Com. of Supply, Argyllshire	13⅓	6	...	...
18	9,120	... ...	Mr J. T. Danson, Barrister-at-Law	26⅔	13⅓	...	...
19	9,121	... ...	Pickering & Smith, Estate-Agents	20	8	60	60
20	9,122	... ...	Sir Henry T. de la Beche, C.B.	24	12	120	12

(*a*) To be varied according to the size of the towns. (*b*) The largest convenient scales.
(*c*) " The larger the better."

No. in Series.	Treasury Register Number.	Date.	Party replying.	Scale recommended.			
				Rural Districts.		Towns.	
				Draft.	Engraved.	Draft.	Engraved.
		1853.		Inches to a Mile.			
21	9,123	May 4	R. J. & H. Clutton, Estate-Agents	20	8	60	60
22	9,124	... ..	Sir W. C. Trevelyan, Bart. .	24	6	120	60
23	9,125	... ...	Mr Charles Bailey, Land-Agent	26⅔	13⅓	80	40
24	9,301	... 6	Lord Rosebery . . .	24	6	120	60
25	9,302	... ...	Mr I. K. Brunel, Mr R. Stephenson, M.P., and Mr J. Locke, M.P. .	20	1	20	...
26	9,303	... ...	Mr A. C. Ramsay, Director of Geological Survey . .	24	12	...	...
27	9,424	... 7	Com. of Supply, Fifeshire .	26⅔	13⅓	...	...
28	9,425	... ...	Chairman of Quarter Sessions, Haddington . . .	12	6	60	60
29	9,532	... 9	Mr E. W. Wilmot, Estate-Agent	24	6	60	60
30	9,533	... ...	Lord Hatherton . .	24	...	120	24
31	9,534	... ...	Com. of Supply, Perthshire .	12	6	...	...
32	9,535	.. ...	Mr George Dundas, M.P. .	24	6	120	60
33	9,536	... ...	Provost of Dundee . .	12	6	264	132
34	9,537	... ...	Mr Jonathan Pym . .	24	6	120	60
35	9,541	... ...	Com. of Supply, Berwickshire .	24	6	120	60
36	9,544	... ...	Trustees of the Harbour, Dundee	12	6	264	132
37	9,545	... ...	Mr J. Hope, Deputy-Keeper of the Signet	24	12	120	60
38	9,546	... ...	Daniel Smith & Son, Land-Agents	26⅔	...	...	...
39	9,550	... 10	President of the Geological Society	24	12	...	...
40	9,596	... ...	Mr T. Smith, Woodley, Land-Agent	24	12	120	60
41	9,703	... 11	Com. of Supply, Linlithgowshire	24	6	120	60
42	9,704	... ...	Davis and Vigers, Land-Agents	24	12	120	60
43	9,713	... ...	Mr S. Eddy, Land-Agent .	24	6	120	60
44	9,720	... ...	Society for promoting the Amendment of the Law . .	26⅔	13⅓	120	60
45	9,733	... ...	Mr C. L. Bradley, Land-Agent .	26⅔	13⅓	80	60
46	9,740	... ...	Mr S. Vessey, Land-Agt. & Valuer	26⅔	...	...	...
47	9,804	... 12	Mr James Johnstone, M.P. .	24	1	...	...
48	9,878	... 13	Com. of Supply, Dumfriesshire	26⅔	6	...	...
49	9,899	... ...	Mr A. E. Lockhart, M.P. .	24	12	120	60
50	9,914	... ...	Com. of Supply, Roxburghshire	24	12	(*a*)	(*a*)
51	9,970	... 14	Metropolitan Commis. of Sewers	...	...	120	120
52	10,056	... 16	Ecclesiastical Commissioners .	20	8	60	60
53	10,083	... ...	Viscount Ebrington . .	24	12	120	24
54	10,212	... 17	Mr John Meadows White .	26⅔	26⅔	120	120
55	10,259	... 18	Mr C. Neale, Land Agt. and Valuer	26⅔	13⅓	80	40
56	10,566	... 21	Mr Thomas Sopwith . .	40*b*	...	40*b*	...
57	{10,080 / 10,567}	... 16 / ... 21	Com. of Supply, Dumbartonshire	24	12	120	60
58	10,569	... ...	Com. of Supply, Renfrew .	(*c*)	(*d*)	...	...
59	10,595	... ...	Poor-Law Board . .	26⅔	...	(40 or	80)
60	10,672	... ...	Local Director, Geological Survey of Ireland	24	6	...	...

(*a*) "Larger than 5 feet."

(*b*) A measured skeleton triangulation only.

(*c*) As large as can be granted.

(*d*) Such as to admit of accurate admeasurement of the areas.

No. in Series.	Treasury Register Number.	Date.	Party replying.	Scale recommended.			
				Rural Districts.		Towns.	
				Draft.	Engraved.	Draft.	Engraved.
		1853.		Inches to a Mile.			
61	10,845	May 26	Mr A. Smollet, M.P. . .	24	12	120	60
62	10,888	... 27	Colonel Hunter Blair, M.P. .	24	6	120	60
63	10,888	... ...	Com. of Supply, Ayrshire .	24	6	120	60
64	10,889	... ...	Lieut.-General Arbuthnot, M.P.	24	6	120	60
65	10,953	... 28	Highland and Agricultural Society	(*a*)	(*a*)	...	...
66	10,996	... 30	Mr J. E. Elliot, M.P. . .	24	12	(*b*)	...
67	11,166	... 31	Lord Wrottesley . .	(24 to	26⅔)	60 to	120)
68	11,326	June 1	Com. of Supply, Co. of Edinburgh	26⅔	1	...	...
69	11,857	... 8	Com. of Supply, Kincardine .	20*c*	6	60	30
70	11,889	... ...	Duke of Devonshire . .	20	12	60	60
71	11,934	... 9	Com. of Supply, Peebles .	24	12	120	60
72	11,953	... ...	Sir G. G. Montgomery, Bart., M.P.	24	12	120	60
73	11,998	... 10	Com. of Supply, Nairnshire .	26⅔	1	120	1
74	12,189	... 13	Chancellor of the Duchy of Lancaster	24	12	120	60
75	12,190	... ...	Messrs Stevenson, Salt, and Sons	24	12	120	60
76	12,204	... ...	Mag. and Town-Council, Aberdeen	24	6	120	60
77	12,237	... 14	Lord Lovat . . .	24	12	120	60
78	12,347	... 16	St Andrews University .	24	12	120	60
79	12,611	... 20	Board of Supervision for Relief of the Poor	26⅔	1	120	60
80	12,962	... 24	Lieut.-Col. Hon. L. Maule, M.P.	24	12	60	60
81	13,239	... 29	The Earl of Rosse . .	20	1	60	60
82	13,327	... 30	Mr Walter Coulson, Q.C. .	26⅔	26⅔	120	120
83	14,003	July 7	Marquis of Tweeddale . .	24	1	...	...
84	14,418	... 14	Hon. Charles Gore, Commissioner of Woods, &c. . .	26⅔	8	60	60
85	15,252	... 25	Sir David Brewster . .	12	6	120	60
86	15,312	... 26	Mr E. H. J. Craufurd, M.P. .	24	6	120	60
87	15,449	... 27	Mr James MacGregor, M.P. .	20	1	60	20
88	15,554	... 29	The Lord Advocate . .	24	12	120	120
89	15,801	Aug. 1	The Rev. Dr Dewar, Principal of Aberdeen University . .	12	6	120	60
90	16,064	... 4	Mr Thos. Huskinson, Estate-Agent	26⅔	13⅓	120	60
91	16,338	... 9	Mr A. Doull, Civil Engineer .	24	24	120	120
92	16,497	... 11	Mr J. Macquorn Rankine, Civil Engineer, &c. . . .	24	6	60*d*	60*d*
93	16,809	... 16	Mr Thomas Woollcombe .	26⅔	13⅓	120	60
94	17,450	... 23	Mr Philip Park, Civil Engineer	24	6	120	60
95	17,451	... ...	Mr C. Piazzi Smyth, F.R.S.L. & E., &c.	24	12	240	120*e*
96	17,622		Mr James Jerwood . .	13⅓	13⅓	120	...
97	17,796	... 29	Mr James Forsyth . .	24	12	120	60
98	17,815	.. ...	Mr Lewis D. B. Gordon .	24	12	120	60
99	17,962	... ...	Mr Robert Dawson . .	26⅔	...	...	...
100	18,128	Sept. 2	Mr R. B. Grantham . .	24	12	120	60
101	18,268	... 3	Colonel Stopford Blair . .	24	6	120	60

(*a*) "Larger than 6 inches." (*b*) "Larger than 5 feet."

(*c*) Not less than 20 in low country and 6 in hill country.

(*d*) "120 in special cases."

(*e*) "120 for first-class towns, 60 for second-class towns."

No. in Series.	Treasury Register Number.	Date.	Party replying.	Scale recommended. Rural Districts. Draft.	Rural Districts. Engraved.	Towns. Draft.	Towns. Engraved.
		1853.		Inches to a Mile.			
102	18,346	Sept. 6	Mr H. M'Lauchlan	24	12	120	60
103	18,403	... 7	Mr James J. Beattie	20	5	105$\frac{3}{5}$	52$\frac{4}{5}$
104	18,546	... 10	Mr J. R. Wright	24	12	120	60
105	18,568	... ...	Mr J. H. Williams	24	12	120	60
106	18,647	... 12	Mr W. Ranger, C.E.	12	6	120	24
107	18,775	... 14	Mr William Murton	24	12	...	..
108	18,854	... 15	Messrs Fox, Henderson, & Co.	26$\frac{2}{3}$	13$\frac{1}{3}$	240	120
109	19,264	... 22	Mr Charles Osborn	24	12	120	60
110	19,325	... 23	Viscount Dalrymple, M.P.	20	12	60	...
111	19,545	... 28	Com. of Supply, Forfarshire	(*a*)	6	...	...
112	19,712	... 30	Mr G. W. Carrington	24	12	96	48
113	20,265	Oct. 10	Mr J. W. Nicoll	24	6	...	...
114	20,513	... 14	Mr W. E. Gaine	24	12	120	120
115	20,514	... ...	Mr Lucius H. Spooner	20	1	...	...
116	21,514	... 28	The General Board of Health	24	24 & 6	120	120
117	21,515	... ...	Mr John M'Millan	(*b*)	(*b*)	...	...
118	22,233	Nov. 5	The Statistical Society	·0004	·000016	·0008	·00008

(*a*) As large as will render it available and useful for plans of estates, railways, &c.
(*b*) Large enough to give correct measurements of fields, &c.

The following Table contains a Synopsis of the above. In the upper column is given the number of inches to a mile, as recommended to be drawn or engraved; and in the under column is given the number of replies in favour of each separate scale.

SUMMARY,

For Rural Districts.

DRAFT PLANS.

Inches to Mile.	6	12	13$\frac{1}{3}$	20	24	25$\frac{1}{3}$	26	26$\frac{2}{3}$	40
Replies in favour of the above Scale.	30	8	2	12	64	1	1	23	1

ENGRAVED.

Inches to Mile.	1	5	6	8	10	12	13$\frac{1}{3}$	24	26$\frac{2}{3}$
Replies in favour of the above Scale.	21	1	47	4	1	41	10	2	5

Note.—From the Replies of the Commissioners of Supply of the different Counties, it appears that fourteen counties are in favour of having County Maps engraved on the Scale of 6 inches to a mile; four in favour of 12 inches to a mile; and four in favour of 1 inch to a mile. No Replies appear to have been received from the other counties.

For Towns.

DRAFT PLANS.

Inches to Mile.	20	24	40	60	80	96	$105\frac{2}{3}$	120	132	240	264
Replies in favour of the above Scale.	1	4	2	29	6	1	1	65	1	2	2

ENGRAVED.

Inches to Mile.	1	6	10	12	20	24	30	40	48	$52\frac{4}{5}$	60	120	132
Replies in favour of the above Scale.	1	1	1	2	1	3	1	3	1	1	67	10	2

N.B.—Fifteen have not mentioned the Scale, but it appears from the notes appended, that they are all in favour of a larger Scale than the Six-Inch.

Note.—Replies received from four County Towns, three in favour of the 6-inch Scale and one in favour of the 1-inch Scale.

SCIENTIFIC INTELLIGENCE.

MINERALOGY.

1. *On the Formation of Crystallized Minerals. By Aug. Frevermann.* (*Annalen der Chemie*, 1853, vol. lxxxviii., p. 120.)—A series of experiments with which I have been lately engaged seem to throw some light on the formation of crystallized minerals from aqueous solutions. I started upon a conviction that crystals found in geodes could have been formed neither by evaporation nor by refrigeration of saturated solutions, and I think I have suceeded in discovering the mode of formation of such minerals. The method is equally applicable to very soluble or slightly soluble bodies, and admits of an infinite variety of modifications in its mechanism. Its principle is nothing else than a gradual alteration of the affinity of the solvent to the dissolved body, so that the precipitation occurs very slowly. The gradual change of chemical force is obtained by the diffusion of one liquid into another, such as in mixing produce a solid precipitate. The arrangement of the apparatus is the same as in Graham's experiments. Powdered chromate of potash was placed in the bottom of a long glass cylinder, and powdered nitrate of lead in the bottom of another; both were then filled with water,

and placed in a large beaker-glass, which contained water enough to cover the two cylinders. In a few months the nitrate of lead had diffused out into the beaker-glass, and formed several beautiful amorphous compounds on the edge of the cylinder in which the chromate had been placed. In the interior of the cylinder, beautiful pink, highly refractive needles of Rothbleierz (PbO, CrO_3) were deposited, also little dark-red rhombic plates of Melanochroit ($3PbO, 2CrO_3$). The needles of neutral chromate found in this manner attained to three or four millimetres, and then fell to the bottom of the cylinder, where the conditions of their development were wanting. Had it not been for this circumstance, they would, no doubt, in three or four months, have got to half an inch, or even more. Some crystals of Weissbleierz (PbO, CO_2) formed in the same vessel, owing, no doubt, to the circumstance that the chromate contained some carbonate of potash. In a similar manner I obtained crystals of calc-spar, also rhombic plates of $2CaO, HO, PO_5 + 4HO$, and some shining needles, which I believe to be $3CaO, PO_5$.

As this method is perfectly general in its principle, and proves applicable to such compounds as carbonate and chromate of lead, we may safely affirm, that the insolubility of a compound will no longer prevent its being prepared in a crystalline form. It appeared in these experiments, as if the great length of time which elapsed before the crystals formed, was owing to the salts not diffusing out rapidly enough; I therefore modified the form of experiment by placing a vessel full of dry salt inside a large vessel, containing a solution just sufficient in quantity to cover the inner vessel. A large precipitate formed on the undissolved salt, and in a few days little crystals were perceptible in the amorphous mass, which continued to grow as long as the materials lasted. In this way I hope to obtain good-sized crystals of heavy-spar, calc-spar, sulphate of lead (Schwerbleierz), pyromorphite ($3(PbO, PO_5) + PbCl$), apatite, &c. By diffusion of a solution of silicate of potash into one of aluminate of potash, I hope to obtain felspar. The crystallization of very soluble compounds may be accomplished by a similar process. Thus, if a solution of sulphate of iron in a beaker-glass is covered with a thin stratum of water, and alcohol gently poured on the top of that, a good and rapid crystallization is obtained. It is probable that in like manner crystals may be prepared from an acid, an alkaline, an alcoholic, or an ethereal solution; and that the separation of two bodies by alteration of the solvent, so often employed in organic chemistry, may thus be combined with a separation by means of crystallization.

The above-mentioned crystals were identified with the minerals, without the aid of chemical analysis; but as in each experiment the number of possible results was limited, and as the crystals agreed in their general chemical deportment and in their physical properties, as well as in their mode of aggregation and geometrical forms, with the minerals named, chemical analysis could hardly have increased the certainty of my conclusions.—(*Quarterly Journal of the Geological Society*, vol. ix., No. 36.)

2. *Artificial Production of Diamond Powder.*—Some considerable sensation has been produced in the scientific circles of Paris, by the announcement of the artificial formation of diamond powder. M. Despretz has made two communications to the Académie des Sciences upon carbon. In these, he states, that placing at one, the inferior, pole of a voltaic battery, a cylinder of pure charcoal (its purity being secured by preparing it from crystallized white sugar-candy), and at the superior pole a bundle of fine platinum wires, so arranged that the charcoal was in the red portion of the electric arc, and the platinum in the violet; he found the carbon volatilized, and collected on the platinum wires in a changed state. In these experiments, the current has been continued during a month in activity, and the powder collected on the wires has been found to be sufficiently hard to polish rubies with great rapidity, and when burnt, it left no residue. M. Despretz asks himself, Have I obtained crystals of carbon which I can separate and weigh, in which I can determine the index of refraction and the angle of polarization, without doubt? No. I have simply produced by the electric arc, and by weak voltaic currents, carbon crystallized in black octohedrons, in colourless and translucent octohedrons, in plates also colourless and translucent, which possess the hardness of the powder of the diamond, and which disappear in combustion without any sensible residue. A similar result has been obtained by decomposing a mixture of chloride of carbon and alcohol, by weak galvanic currents. The black powder deposited, was found to possess equal hardness with that which was sublimed, and rubies were readily polished by it. A few years since, graphite and coke were formed from diamonds. We now appear to be advancing towards the conversion of graphite and coke into diamonds.—(*Athenæum*, No 1355.)

GEOLOGY.

3. *Use of Salt among the Natives in Namaqua Land, South Africa.*—The Namaquas occasionally use salt, but they set no store upon it. There is no doubt, that people who live on meat and milk would require salt much less than those who live on vegetables; but half the Damaras subsist simply on pig-nuts,—the most worthless and indigestible of food, and requiring to be eaten in excessive quantities to afford enough nourishment to support life. The Hottentots of Walfisch Bay, who live almost entirely on the nara gourd, and who have the sea on one side, and salt springs in front of them, hardly even take the trouble to collect salt, which they certainly would do if they felt that craving for it which distresses many Europeans. The last fact that I have to mention with reference to salt, is that the game in the Swa Kop, do not frequent the salt rocks

to lick them, as they do in America.—(*Galton on Tropical South Africa*, p. 183.)

METEOROLOGY.

4. *Some observations desirable to be made with reference to the Glaciers of Norway.*

I briefly refer to a few of the many observations desirable to be made with reference to the Glaciers of Norway, which may be recommended to future travellers:—

1. To ascertain whether unquestionable and well-defined snow-fields occur north of lat. 60°; the level of the snow-line, and the period of the year at which it retreats highest.

2. To examine the glaciers on the west slope of the Justedal mountains, and at the head of Sogndal and Veitestrandswand, and to trace to their origin the remarkable granite boulders which seem to be derived from thence (p. 155).

3. To select amongst the glaciers of the Justedal range one or more suitable for careful observations of progression, both during the height of summer, and from year to year. The Lodals glacier is probably one of the best.

4. To ascertain carefully the snow-line of the Folgefond and in Nordfiord (between Justedal and the sea).

5. To visit and describe the glaciers of the Ymesfield, &c.

6. To explore the country to the north and north-west of Sneehättan on the Dovrefield; to observe its geology, and ascertain the level and extent of its snow-fields.

7. Generally, in the preceding excursions, to notice the occurrence of grooved and polished rocks, and the direction by compass of the striæ, especially on level places, not in the declivities of valleys. The attempt to trace generally the boulders to their origin, could only be attempted by persons familiarly conversant with the intricate and obscure geology of Norway. But moraines should be watched for and sketched. That of Vasbotten, near Stavanger, mentioned by Esmark, would be worthy of a visit.

8. In Nordland, and the higher north, the traveller may explore the Börgefield, between the Namsen and Vefsen, rivers frequented for their fishing by numerous tourists.

9. The glaciers and snow-fields of Fondal (lat. 66°, 67°) would unquestionably repay a week or a fortnight's research. From the steamboat station of Rödö, the Melsfiord, Holandsfiord, and Glomsfiord, might be easily visited, of which the two first at least contain glaciers at a very low level. The mountains of Fondal are in a great measure detached from the interior chain, and it is probable that the explorer might return from Gilleskaal, beyond Cape Kunnen, by the landward side, to the head of the Ranenfiord (lat. 66° 10′), and rejoin the steamer.

10. The promontory of Lyngen, with its numerous glaciers,

might be made the object of an excursion from Tromsö, with the aid of the steamer.

11. A detailed examination of the Bergsfiord, Jökulsfiord, and Qvenanger range, has been already recommended (p. 84).

12. Every opportunity should be taken to ascertain the direction of the abrading and smoothing agency, which has left such extraordinary traces along the coast, between the Throndhjem-fiord and the Lofoddens; and in general it should be sought to observe how far the striæ correspond or not in direction with the general declivity of the ground, or whether they are in any case extensively parallel with the coast.

13. The limits of vegetation of the birch and the snow-line should be observed wherever practicable; but with regard to the latter, the great difficulty of ascertaining the extreme limit of recession of the snow should be borne in mind, and the time of year, the character of the season, and the exposure, should be particularly noticed.

14. The meteorology of Norway is in a state which is not creditable to the acknowledged intelligence of the people, and the eminence of its scientific men. I know of but two places, Christiania and Kaafiord, (separated by 10° of latitude) of which the mean temperature is known with any accuracy. This is lamentable in a country whose climate is one of the most interesting in Europe. The means of remedying it seem easy. Let observations, in the first instance, be confined to the *thermometer*. It is impossible to doubt that a net-work of say fifty stations, might be quickly established over the entire country. The intelligent officers of the Royal Marine and Trigonometrical Survey; the clergy (who have almost all had a university education); the masters of schools and academies,—like my well-informed friend, M. Blom, at Tromsö; the active magistrates and civil officers; even the station-holders and substantial merchants on the steamboat routes, would probably, in many instances, lend a cheerful aid to so simple and interesting an inquiry; whilst the combination of the results could not be placed in better hands than those of the Professors of Christiania.—(*Norway and its Glaciers, by Professor James Forbes*, p. 245.)

5. *Theory of the Pile and the Aurora Borealis.*—M. de la Rive, the celebrated physicist of Geneva, has presented to the Academy the first volume of a treatise on Theoretical and Applied Electricity, which he has published in London, and of which he is now preparing an edition in French. In explaining the plan of his work, M. de la Rive dwelt more especially on the theory of the pile. He has always been a defender of the chemical theory; but, while acknowledging the influence of chemical action, he now recognizes, that we cannot always admit that chemical action precedes the production of electricity, and he is led to consider the two phenomena as commonly simultaneous, and due to a more general cause, viz., molecular polar-

ization, which is established at the moment of contact of two bodies susceptible of acting chemically on one another. M. de la Rive also expresses his opinion on the cause of the aurora, which he explains, not by a radiation of the polar magnetism, but by a purely electrical action. After examining nearly all recent observations, he believes that he may attribute this phenomenon to the electricity with which the currents of air are charged, that rise from the equatorial regions, and travel in the upper atmosphere towards the poles, where they combine with the negative electricity of the earth, forming, under the influence of the magnetic pole, true luminous arches.—(*American Journal of Science and Arts*, vol. xvi. No. 47, 2d Series, p. 274.)

6. "*Piroróco*" *or Bore that occurs in the Guamá River at Spring Tides.*—About thirty miles above Pará the piroróco commences. There was formerly an island in the river at this point, but it is said to have been completely washed away by the continual action of the bore, which, after passing this place, we rather expected to see, now being the time of the highest tides, though at this season (May) they are not generally high enough to produce it with any force. It came, however, with a sudden rush, a wave travelling rapidly up the stream, and breaking in foam all along the shore and on the shallows. It lifted our canoe, just as a great rolling ocean-wave would do, but, being deep water, did no harm, and was past in an instant, the tide then continuing to flow up with great velocity. The highest tide was now past, so at the next we had no wave; but the flood began running up instantaneously, and not gradually, as is generally the case. On our way down, I again encountered the "piroróco," when I hardly expected it. We had gone in-shore at a sugar estate, to wait for the tide, when the agent told us we had better put out further into the stream as the piroróco beat there. Though thinking he only wished to frighten us, we judged it prudent to do as he advised; and, while we were expecting the tide to turn, a great wave came suddenly rushing along, and breaking on the place where our canoe had been at first moored. The wave having passed, the water was as quiet as before, but flowing up with great rapidity. As we proceeded down the river we saw everywhere signs of its devastations in the uprooted trees which lined the shores all along, and the high mud banks where the earth had been washed away. In winter, when the spring tides are highest, the "piroróco" breaks with terrific force, and often sinks and dashes to pieces boats left incautiously in too shallow water. The ordinary explanations given of this phenomenon are evidently incorrect. Here there is no meeting of salt and fresh water, neither is the stream remarkably narrowed where it commences. I collected all the information I could respecting the depth of the river, and the shoals that occur in it. Where the bore first appears there is a shoal across the river, and below that the stream is some-

what contracted. The tide flows up past Pará with great velocity, and entering the Guamá river comes to the narrow part of the channel. Here the body of tidal water will be deeper and flow faster, and coming suddenly on to the shoal will form a wave, in the same manner that in a swift brook a large stone at the bottom will cause an undulation, while a slow flowing stream will keep its smooth surface. This wave will be of great size, and, as there is a large body of water in motion will be propagated onwards unbroken. Wherever there are shallows, either in the bed or on the margin of the river, it will break, or as it passes over slight shoals will be increased, and as the river narrows will go on with greater rapidity. When the tides are low they rise less rapidly, and at the commencement a much less body of water is put in motion; the depth of the moving water is less, and does not come in contact with the bottom in passing over the shoal, and so no wave is formed. It is only when the body of water in motion as the tide first flows in is of sufficient depth, that it comes in contact with the shoal, and is, as it were, lifted up by it, forming a great rolling wave. It appears, therefore, that there must exist some peculiar formation of the bottom, and not merely a narrowing and widening in a tidal river to produce a bore, otherwise it would occur more frequently than it does.—(*Travels on the Amazon and Rio Negro, by Alfred R. Wallace*, p. 114.)

7. *Mirage of South Africa.*—We were surrounded by a mirage of the most remarkable intensity,—objects 200 yards off were utterly without definition; a crow, or a bit of black wood, would look as lofty as the trunk of a tree,—pelicans were exaggerated to the size of ships with the studding sails set, and the whole ground was wavy and seething, as though seen through the draught of a furnace. This was in August, the month in which mirage is most remarkable here; it is excessive at all times, and has been remarked by every one who has seen the place. A year and a half later I tried on two occasions to map the outline of the bay, which was then comparatively clear, but still the mirage quite prevented me; an object which I took as a mark from one point being altogether undistinguishable when I had moved to my next station.—(*The Narrative of an Explorer in Tropical South Africa, by Francis Galton*, p. 16.)

8. *Majestic Cloud seen from the Jungfrau.*—It was four o'clock when we reached the summit of the Jungfrau, and we staid half an hour. The view to the east was generally clear. The Finsteraar and Schreckhorn, the glacier of Aletsch, the Monch and Eigher,—and we got a glimpse of the bottom of the valley of Grindelwald. The view to the west was in one respect scarcely less remarkable, for there a magnificient cumulous-headed cloud stood in wonderful majesty, reaching apparently from the valley to at least 2000 feet above us. It was a glorious sight, a single cloud at least 10,000 feet high.—(*Norway and its Glaciers, by Prof. James Forbes.*)

HYDROGRAPHY.

10. *A new method for taking Deep Sea Soundings.*—Hitherto a continuous series of soundings in deep water has been rendered difficult by the fact of each sounding costing the ship a fresh line; however strongly the line was made, when once out it has never been recovered. The Americans have invented a mode by which the weight on touching the bottom is detached; so that the line may be drawn back with ease.—The following is an account of this ingenious contrivance:—"A hole is drilled through a 64 lb. or heavier shot, sufficiently large to admit a rod of about three quarters of an inch in diameter. This rod is about 12 or 14 inches in length, and with the exception of about 1½ inch at the bottom, perfectly solid. At the top of the rod are two arms extending one from each side; these arms being upon easily-acting hinges, are capable of being raised or lowered with very little power. A small branch extends from the outside of each of them, which is for the purpose of holding, by means of rings, a piece of wire by which the ball is swung to the rod. A piece of rope is then attached by each end to the arms, to which again is joined the sounding line. The ball is then lowered into the water, and upon reaching the bottom, the strain upon the line ceases, and the arms fall down, allowing the ball to detach itself entirely from the rod, which is then easily drawn in,—the drilled portion of which is discovered to be filled with a specimen of that which it has come in contact with at the bottom." With this apparatus, aided by the host of assistants whom Lieut. Maury's visit to Europe will doubtless bring to the great work of exploration, the ocean bed may become in time as well known to us as the bed of the Thames or that of Hudson.—(*Athenæum.*)

ZOOLOGY.

11. *The Committee appointed at the Meeting of the American Philosophical Society on the 30th of February last, to examine and report upon a collection of fine Wools, presented by the King of Saxony to Peter A. Browne, Esq., of this city:*—

Report, That they have attended to the duty imposed upon them by their appointment, and have received, from the kind politeness of Mr Browne, much aid and information in relation to the subjects of their inquiries. It is already known to the Society that the attention of this gentleman has been for some time directed to the minute and critical investigation of hair and wool, and that by means of assiduous microscopic and micrometric examination of these bodies he has been enable to arrived at results, some of which appear to have been before unknown, and others, if known, very little noticed. Among these, he claims the following:—

That he was the first to point out the exact difference between *hair* and *wool*; and that he originated the division of sheep into two *species*, viz. the hairy and the woolly.

That by the application of the well-known laws of hybridism, he was the first to shew that by crossing these two species, a self-supplying, permanent race of animals cannot be produced.

That he was the first to demonstrate, by actual measurement, that as fine wool can be grown in the United States as in any country in the world.

From the results of his examination of a great number of specimens of wool from various parts of this country, he claims to have discovered that by drawing a diagonal line across the United States, corresponding somewhat with the line of tidewater, one may point out the respective districts where the woolly and the hairy sheep may, and may not, be bred with success.

The Committee proposed not to enter into a critical investigation of the theories of Mr Browne, in relation to hair and wool; but from the laborious and earnest attention which he has given to the subject, they are inclined to regard his opinions and conclusions as being well worthy of considerate attention from the naturalist, the agriculturist, and the manufacturer of fabrics in which wool forms an entire or a component part. If, as he asserts, the hairy and the woolly sheep are of different species, and that by their breeding together a degenerate race is produced, yielding a mixed fleece of hair and wool, and inferior in other respects; it is surely important that the fact should be known, and claim serious attention wherever sheep are bred, that the two varieties or races may be kept separate, as appears to be the case in the best sheep-folds in Saxony.

The collection of wools presented by the King of Saxony to Mr Browne, consists of upwards of six hundred specimens, very neatly put up and labelled, embracing varieties from the principal districts in that country where the growing of wool is pursued as a branch of agricultural economy. These specimens exhibit the quality of wool taken from different parts of the same animal, as well as the varieties from the different breeds of sheep, and the various districts in which they are produced.

In relation to this collection of Saxony wools, and illustrative of the subject of sheep-breeding and wool-growing, Mr Browne has favoured the Committee with a communication, which is appended to this report.

CHAS. B. TREGO.
A. L. ELWYN.
G. M. JUSTICE.

To Charles B. Trego, Alfred L. Elwyn, and George M. Justice, Esquires, Committee of the American Philosophical Society, appointed to examine the Wools presented by His Majesty the King of Saxony to Peter A. Browne, of Philadelphia.—Gentlemen, the kingdom of Saxony is divided into four circuits and fourteen counties, and the specimens I now exhibit to you (numbering 628) represent the animals belonging to the principal stock sheep-folds in all the circuits, and in nearly all the counties; so that the cabinet may be considered as presenting a fair view of the existing state of sheep-husbandry in Saxony.

Saxony is the smallest kingdom in Europe; containing, according to some writers, 5300, and according to others, 5640 square miles; having, for its area, about one-eighth that of Pennsylvania, and about one-eleventh that of Virginia, yet it is said to maintain 25,000,000 sheep. They export annually an immense quantity of wool, and their own manufactories of that article employ 25,000 people.

To be perfectly satisfied that their sheep are of a very superior kind, and that their wool is of the finest sort, you have only to examine these specimens, and compare them with the samples of fine wools brought by Mr Fleishman, from most parts of Europe, at the instance of the Federal Government.

How did Saxony become possessed of this inestimable treasure?

According to the celebrated agriculturist, M. Thaër, Germany, before the introduction of the merinos, had three varieties of sheep; neither of which were held in high estimation. In 1765, Augustus Frederick, then Elector of Saxony, procured from Spain, 200 merinos, which he placed at Stolpgen, in the county of Hayn, and circuit of Dresden. Against this innovation, popular prejüdice at first ran high, but it gradually subsided with the progress of experiment; and, in 1777, so much had these sheep risen in public estimation, that the elector determined to import 300 more. The agent sent to Spain could procure only 110, and of these many died during and soon after the transportation; but they, like those previously obtained, were selected from the best Spanish flocks; and then commenced the celebrated establishments of Rennersdorf, in the county and circuit of Bautzon and of Lochmule, in the county of Niederforchheim, in the circuit of Zwickau. It was upon this comparatively slender foundation that the art of sheep-breeding was erected in Saxony. But it could never have attained its present great celebrity, but for the rigid observance of the rule, in breeding, to keep these merinos entirely separate from all other sheep; their blood was, by this means, preserved pure; no mixture of them with either of the pre-existing races being allowed, on any pretence whatever. And to this day, the Saxon sheep-breeder will not permit one to lose sight of this important fact; in proof of which I call your attention to this clause in the letter of Mr V. Kirchen, the farmer of the stock sheep-fold of the Duke of Parma, in the county of Dresden, called "Weistropp," which accompanies these 16 beautiful specimens,—"*These sheep are the descendants of the original importation from Spain of* 1778."

I consider this collection of specimens of Saxony wool as a practical illustration of my theory of sheep-breeding and fine wool-growing, verifying the rule which I laid down, long before I saw these specimens, that to insure a pure and perfect breed of fine-woolled sheep, it is absolutely necessary *to preserve the two species of these animals entirely separate*, and not to mix the merinos with the common sheep of the country, as is too often done in the United States.

If any American sheep-breeder still entertains a latent doubt as to the soundness of this rule, he is invited to inspect this collection, to have passed, separately, in review, the specimens from the various sheepfolds, aud particularly to notice that this is not a collection of *picked locks*, from those parts of the animal where the wool is usually the finest; but that in order to afford the greatest facility of judging of the sheep from the wool, samples are given from all parts of the body, the shoulders, the withers, the back, from under the belly, the tail, and the legs: let these be carefully examined, and they will be found to be *all wool;* not a *hair* to be found upon those parts of the sheep where the impure race commence shewing hair.

I consider this uniformity and entirety of fibre as an unerring test of *purity of blood;* and therefore cannot but regard Saxony as an example, upon a large scale, and worthy of being followed, of the *perfection of sheep-husbandry.*

It will be recollected that I have heretofore shewn, by actual admeasurements with the microscope and micrometer, that as fine wool can be produced in the United States as in any part of the world; there is therefore no deficiency in *climate* or *soil;* all that the American agriculturist requires is to procure a pure breed, and to preserve them uncontaminated by spurious crossings. To obtain the former, I proffer free inspection of my cabinet, where there will be found samples of all the varieties, with references to the sheepfold from which they can be supplied, and even the number of the sheep whose wool is there exposed to view.

In connection with this part of the exposé, I ask particular attention to this suite of specimens from the Manor of Obermylaw, near Rechenbach. It will be recollected that the principal objection to the Saxo-merino sheep has heretofore been, that the staple is short, and consequently that the clip must be light; but these specimens, while they exhibit the maximum fineness, have a staple so long as to obviate entirely this objection. This variety of Saxon wool has not, so far as I know and believe, been before brought to this country, nor have the sheep from which it was taken, made their appearance in the United States; but it must be borne in mind, that as they are only a variety of the merino, the American planter and farmer may, by proper care and attention, produce it here, or he may import these very sheep, and by due management preserve the integrity of their fleece.

Upon the whole, therefore, I submit to you, gentlemen, that his Majesty the King of Saxony has conferred a singular favour upon the United States, in sending hither these specimens, and that he is entitled to the thanks of all good citizens who take an interest in this important branch of industry. I am, &c.

P. A. Brown.

BOTANY.

15. *Microscopical Description of the Protococcus nivalis from the Arctic Regions, by M. Justice.*—The perfect type of the Protococcus nivalis, is a globular cyst, varying in size from the $\frac{1}{2500}$th of an inch to the $\frac{1}{1000}$th of an inch in diameter; each cell or cyst having an opening, whose smallest diameter measures only the $\frac{1}{5000}$th part of an inch. This opening is surrounded by marked serrated or indented lines, as though by the expansion and gradual growth of the cell the opening had also been irregularly expanded. The plant, when perfect, greatly resembles the red currant of our gardens; as it decays the red colouring matter is lost, being gradually superseded by a deep orange, which finally appears to change into a brown, or the cell becomes transparent. In this transparent state, when the cell is broken, the thickness of the enveloping cuticle may be measured, this does not exceed the $\frac{1}{20000}$th part of an inch; and where the opening is preserved, the interior of it becomes of a delicate green colour. Many of the cells exhibit the hexagonal figure instead of being globular; but this is the result of compression, where masses of them have been thrown together. Mingled with the protococcus are fragments of a tissue of reticulated and cellular formation, much resembling some of the infusorial polycystina. So minute are the openings in these that they do not exceed the $\frac{1}{10000}$th part of an inch in diameter.—(*Proceedings of the American Philisophical Society.*)

16. *Dr Kane on Specimens of Vegetable Matter found by him on the Ice Plains of the Polar Seas.*—They consisted of the minute filaments and radicles of two species of moss (undetermined), mingled with the leaves and corticle of a heath, recognizable by the unassisted eye as the Andromeda tetragona; the broken thalli of several lichens, and in one case, the capsule of a saxifrage.

Those were collected at different times during the long ice drift of the late Grinnell expedition, and at distances from land varying from forty to seventy-six miles. They appeared as almost microscopic specks upon the surface of the snow-fields, and would readily elude casual observation. They had been undoubtedly conveyed from the shore over the dry and polished surface of the ice by the action of the winds, and it seemed as if they might be transported in the same manner to indefinite distances, unless arrested by the continued intervention of open water.

Dr Kane alluded to the infusorial dust of South America and Africa, and the diffusion of volcanic ash and scoriæ over extended areas, as also to the presence of acetic and hippuric acids, &c., in the atmosphere, as detected by Fresnel and Horsford. He believed, however, that this was the first instance of an analogous observation with regard to organized and vegetable matter, and he regarded it as having an interesting connection with the protococcus nivalis, and other growths upon a *naked* snow surface.

Dr Kane stated that he had collected the red snow at a point within the arctic circle, as high as lat. 76° 15′, and from the shores of Wellington Channel to those of Greenland. Throughout all this extensive range it *was in no case* found on snow devoid of other vegetable life. It generally occupied dependent valleys and grooves, and was found there in connection with the fronds of lichens, portions of mosses, the catkins of the willow, &c. &c. The intensity of the colouring appeared to bear a certain marked relation to the quantity of such foreign matter present in these localities.

Dr Kane added that Sir Edward Parry had detected this singular vegetable organism on the distant Spitzbergen ice fields, and Saussure, Baer, and others, on isolated Alpine slopes; but that even in these cases, it could not be said that the snow-surface was absolutely without a vegetable nidus. He had himself collected this snow seventy-six miles from any land, and from surfaces which, but for a critical examination, would have seemed altogether pure.

He did not wish his remarks to be understood as bearing upon the general question of the ability of snow-water to afford the necessary ammonia for the supply of the plants, but as simply indicating for many of the heretofore "isolated" localities of the red snow, the pre-existence of a matrix of vegetable character.—(*Proceedings of the American Philosophical Society.*)

MISCELLANEOUS.

17. *Important Scientific Invention.*—A letter from Berlin of the 17th says—"It is well known that the paper prepared for photography grows more or less black by rays of light falling on it. One of our young painters, M. Schall, has just taken advantage of this property in photographic paper to determine the intensity of the sun's light. After more than 1500 experiments, M. Schall has succeeded in establishing a scale of all the shades of black which the action of the solar system produces on the photographic paper:—so that, by comparing the shade obtained at any given moment on a certain paper with that indicated on the scale, the exact force of the sun's light may be ascertained. Baron Alexander von Humboldt, M. de Littnow, M. Dove, and M. Poggendorff, have congratulated M. Schall on this invention, which will be of the highest utility not only for scientific labours, but also in many operations of domestic and rural economy."

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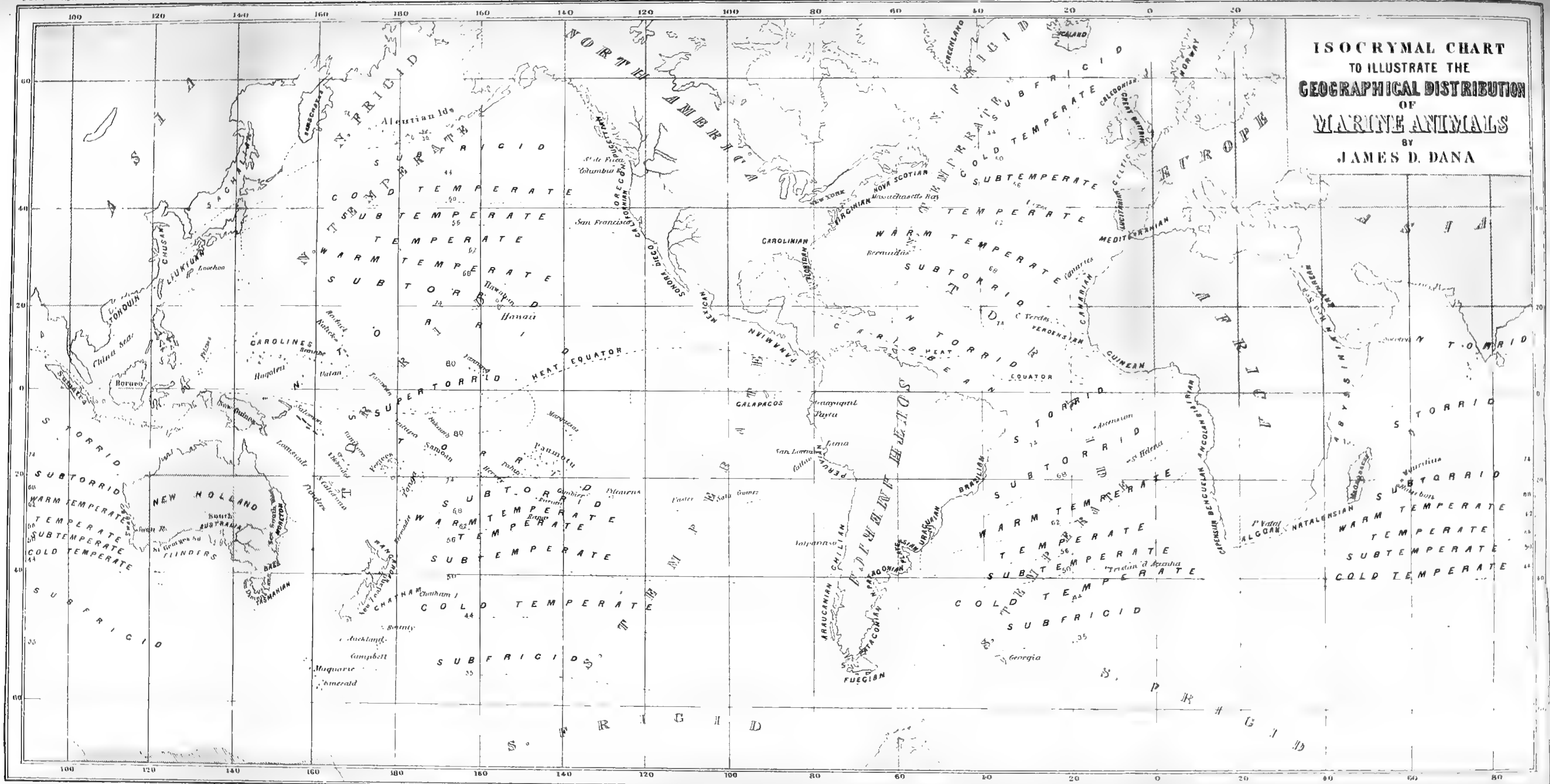

Lithog by W & A K Johnston, Edinr

THE

EDINBURGH NEW

PHILOSOPHICAL JOURNAL.

On an Isothermal Oceanic Chart, illustrating the Geographical Distribution of Marine Animals. With an illustrative Map. By JAMES D. DANA, Esq.

The temperature of the waters is well known to be one of the most influential causes limiting the distribution of marine species of life. Before, therefore, we can make any intelligent comparison of the species of different regions, it is necessary to have some clear idea of the distribution of temperature in the surface waters of the several oceans; and, if we could add also the results of observations at various depths beneath the surface, it would enable us still more perfectly to comprehend this subject. The surface temperature has of late years been quite extensively ascertained, and the lines of equal temperature may be drawn with considerable accuracy. But in the latter branch of thermometric investigation almost everything yet remains to be done: there are scattering observations, but none of a systematic character, followed through each season of the year.

The map (Plate I.) which we present in illustration of this subject, presents a series of lines of equal surface temperature of the oceans. The lines are isocheimal lines, or, more properly, *isocrymal* lines; and where they pass, each exhibits the mean temperature of the waters along its course for the coldest thirty consecutive days of the year. The line for 68° F., for example, passes through the ocean where 68° F. is the mean temperature for extreme cold weather. January is not always the coldest winter month in this climate, neither is the winter the coldest season in all parts of the globe, especially near the equator. On this account we do not restrict the lines to a given month, but make them more correctly the limit of the extreme cold for the year at the place.* Between the line of 74° north and 74° south of the equator, the waters do not fall for any one month below 74° F.; between 68° north and south, they do not fall below 68°.

There are several reasons why *isocrymal* are preferable to summer or *isotheral* lines. The cause which limits the distribution of species northward or southward from the equator is the cold of winter, rather than the heat of summer, or even the mean temperature of the year. The mean temperature may be the same when the extremes are very widely different. When these extremes are little remote, the equable character of the seasons, and especially the mildness of the winter temperature, will favour the growth of species that would be altogether cut off by the cold winters where the extremes are more intense. On this account lines of the greatest cold are highly important for a chart illustrating the geographical distributions of species, whether of plants or animals. At the same time, summer lines have their value; but this is true more particularly for species of the land and fresh-water streams, and for sea-shore plants. When the summer of a continent is excessive in its warmth, as in North America, many species extend far from the tropics that would otherwise be confined within lower latitudes. But in the ocean, the extremest cold in the waters, even in the Polar regions, wherever they are not solid ice (and only in such places are marine species found), is but a few degrees below 32° F. The whole range of temperature for a region is consequently small. The region which has 68° F.

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* The word *isocrymal* here introduced is from the Greek *ισος, equal,* and *κρυμος, extreme cold,* and applies with sufficient precision to the lines for which it is used. These lines are not *isocheimal* lines, as these follow the *mean winter* temperature; and to use this term in the case before us, would be giving the word a signification which does not belong to it, and making confusion in the science.

for its winter temperature, has about 80° for the hottest month of summer; and the line of 56° F. in the Atlantic, which has the latitudes of the state of New York, follows the same course nearly as the summer line of 70° F. In each of these cases the whole extent of the range is small, being twelve to fourteen degrees.*

In fresh-water streams, the waters, where not frozen, do not sink lower than the colder oceans, reaching at most but a few degrees below freezing. Yet the extremes are greater than for the ocean; for in the same latitudes which give for the ocean 56° and 70° F. as the limits, the land-streams of America range in temperature between 30° and 80° F., and the summer warmth, in such a case, may admit of the development of species that would otherwise be excluded from the region.

While, then, both isocrymal and isotheral lines are of importance on charts illustrating distribution over the continents, the former are pre-eminently important where the geography of marine species is to be studied.

The lines of greatest cold are preferable for marine species to those of summer heat, because of the fact, also, that the summer range of temperature for thirty degrees of latitude either side of the equator is exceedingly small, being but three to four degrees in the Atlantic, and six to eight degrees in the Pacific. The July isothermal for 80° F. passes near the parallel of 30°; and the extreme heat of the equatorial part of the Atlantic Ocean is rarely above 84°. The difficulty of dividing this space by convenient isothermals with so small a range is obvious.

It is also an objection to using the isotheres, that those towards the equator are much more irregular in course than the isocrymes. That of 80° for July, for example, which is given on our map from Maury's chart, has a very flexuous course. Moreover the spaces between the isotheres fail to correspond as well with actual facts in geographical distri-

* Moreover, the greatest range for all oceans is but 62° of Fahrenheit, the highest being 88°, and the lowest 26°; while the temperature of the atmosphere of the globe has a range exceeding 150°.

bution. The courses of the cold-water currents are less evident on such a chart, since the warm waters in summer to a great extent overlie the colder currents.

It is also to be noted, that nothing would be gained by making the mean temperature for the year, instead of the extremes, the basis for laying down these lines, as will be inferred from the remarks already made, and from an examination of the chart itself.

The distribution of marine life is a subject of far greater simplicity than that of continental life. Besides the influence on the latter of summer temperature in connection with that of the cold seasons, already alluded to, the following elements or conditions have to be considered: the character of the climate, whether wet or dry; of the surface of the region, whether sandy, fertile, marshy, &c.; of the vegetation, whether that of dense forests or open pasture-land, &c.; of the level of the country, whether low or elevated, &c. These and many other considerations come in, to influence the distribution of land species, and lead to a subdivision of the Regions into many subordinate Districts. In oceanic productions, depth and kind of bottom have an important bearing: but there is no occasion to consider the moisture or dryness of the climate, and the influence of the other peculiarities of region mentioned is much less potent than with continental life.

We would add here, that the data for the construction of this chart have been gathered, as regards the North Atlantic, from the isothermal chart of Lieutenant Maury, in which a vast amount of facts are registered, the result of great labour and study. For the rest of the Atlantic and the other oceans we have employed the meteorological volume of Captain Wilkes of the Exploring Expedition Reports, which embraces observations in all the oceans, and valuable deductions therefrom; also the records of other travellers, as Humboldt, Duperey of the Coquille, D'Urville of the Astrolabe, Kotzebue, Beechey, Fitzroy, Vaillant of the Bonite, Ross in his Antarctic Voyage, together with such isolated tables as have been met with in different Journals. The lines we have laid down are not, however, those of any chart previously constructed, for the reason stated, that they mark the positions where a given temperature is the mean of the coldest month (or coldest thirty consecutive days) of the year, instead of those where this temperature is the mean annual or monthly heat; and hence the apparent discrepancies which may be observed, on comparing it with isothermal charts.

The isocrymal lines adopted for the chart are those of 80°, 74°, 68°, 62°, 56°, 50°, 44°, and 35° of Fahrenheit. The temperatures diminish by 6°, excepting the last, which is 9° less than 44°.

In adopting these lines in preference to those of other degrees of temperature, we have been guided, in the first place, by the great fact, that the isocryme of 68° is the boundary-line of the coral-reef seas, as explained by the author in his Report on Zoophytes.* Beyond this line either side of the equator we have no species of true Madrepora, Astræa, Meandrina, or Porites; below this line these corals abound, and form extensive reefs. This line is hence an important starting-point in any map illustrating the geography of marine life. Passing beyond the regions of coral reefs, we leave behind large numbers of Mollusca and Radiata, and the boundary marks an abrupt transition in zoological geography.

The next line below that of 68° F. is that of 74° F. The corals of the Hawaiian Islands, and the Mollusca also to a considerable extent, differ somewhat strikingly from those of the Feejees. The species of Astræa and Meandrina are fewer, and those of Porites and Pocillopora more abundant, or at least constitute a much larger proportion of the reef material. These genera of corals include the hardier species; for where they occur in the equatorial regions, they are found to experience the greatest range in the condition of purity of the waters, and also the longest exposures out of water.

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* In the author's Report on Geology, 66° F. is set down as the limiting temperature of coral-reef seas; this, however, is given as the *extreme* cold. 68° appears to be the *mean* of the coldest month, and is therefore here used.

Their abundance at the Hawaiian Islands, as at Oahu, is hence a consequence of their hardier character, and not a mere region peculiarity independent of temperature. There are grounds, therefore, for drawing a line between the Hawaiian Islands and the Feejees; and as the temperature at the latter sinks to 74½° F. some parts of the year, 74° F. is taken as the limiting temperature. The Feejee seas are exceedingly prolific and varied in tropical species. The corals grow in great luxuriance, exceeding in extent and beauty anything elsewhere observed by the writer in the tropics. The ocean between 74° F. north of the equator, and 74° F. south, is therefore the proper tropical or torrid region of zoological life.

With respect to the line of 80° F., we are not satisfied that it is of much importance as regards the distribution of species. The range from the hottest waters of the ocean, 88° to 74° F., is but fourteen degrees, and there are probably few species occurring within the region that demand a less range. Still, investigations hereafter made may shew that the hot waters limited by the isocryme of 80° include some peculiar species. At Sydney Island and Fakaafo, within this hot area, there appeared to be among corals a rather greater prevalence than usual of the genus Manopora, which, as these are tender species, may perhaps shew that the waters are less favorable for hardier corals than those of the Feejees, where the range of temperature is from 70° to 80° F.; but this would be a hasty conclusion, without more extended observations. The author was on these islands only for a few hours, and his collections were afterwards lost at the wreck of the Peacock, just as the vessel was terminating the voyage by entering the Columbia River.

It is unnecessary to remark particularly upon the fitness of the other isocrymals for the purposes of illustrating the geographical distribution of marine species, as this will become apparent from the explanations on the following pages.

The regions thus bounded require, for convenience of designation, separate names, and the following are therefore proposed. They constitute three larger groups: the *first*, the *Torrid* zone or *Coral-reef* seas, including all below the isocryme of 68° F.; the *second*, the *Temperate* zone of the oceans, or the surface between the isocrymes of 68° F. and 35° F.; the *third*, the *Frigid zone*, or the waters beyond the isocryme of 35° F.

Regions.	Isocrymal limits.
I. TORRID OR CORAL-REEF ZONE.	
1. Supertorrid,	80° F. to 80° F.
2. Torrid,	80° to 74°
3. Subtorrid,	74° to 68°
II. TEMPERATE ZONE.	
1. Warm temperate,	68° to 62°
2. Temperate,	62° to 56°
3. Subtemperate,	56° to 50°
4. Cold temperate,	50° to 44°
5. Subfrigid,	44° to 35°
III. FRIGID ZONE.	
1. Frigid,	35° to 26°

A ninth region—called the Polar—may be added, if it should be found that the distribution of species living in the frigid zone requires it. There are organisms that occur in the ice and snow itself of the polar regions; but these should be classed with the animals of the continents; and the continental isotherms or isocrymes, rather than the oceanic, are required for elucidating their distribution.

It seems necessary to state here the authorities for some of the more important positions in these lines, and we therefore run over the observations, mentioning a few of most interest. There is less necessity for many particulars with reference to the North Atlantic, as our facts are mainly derived from Lieut. Maury's chart, to which the author would refer his readers.

1. North Atlantic.—*Isocryme of* 74° F.—This isocryme passes near the reefs of Key West, and terminates at the north-east cape of Yucatan; it rises into a narrow flexure parallel with Florida along the Gulf Stream, and then continues on between the Little and Great Bahamas. To the eastward, near the African coast, it has a flexure northward, arising from the hot waters along the coast of Guinea, which reach in a slight current upward towards the Cape Verde

Islands. The line passes to the south of these islands, at which group Fitzroy, in January of 1852, found the sea-temperatures 71° and 72° F.

Isocryme of 68° F.—Cape Canaveral, in latitude 27° 30′, just north of the limit of coral reefs on the east coast of Florida, is the western termination of the line of 68°. The Gulf Stream occasions a bend in this line to 36° north, and the polar current, east of it, throws it southward again as far as 29° north. Westward it inclines much to the south, and terminates just south of Cape Verde, the eastern cape of Africa. Sabine found a temperature of 64° to 65° F. off Goree, below Cape Verde, January 1822; and on February 9, 1822, he obtained 66½° near the Bissao shoals. These temperatures of the cold season contrast strikingly with those of the warm season. Even in May (1831) Beechey had a temperature of 86° off the mouth of Rio Grande, between the parallels of 11° and 12° north.

Isocryme of 62° F.—This isocryme leaves the American coast at Cape Hatteras, in latitude 35½° north, where a bend in the outline of the continent prevents the southward extension of the polar currents close along the shores. It passes near Madeira and bends southward, reaching Africa nearly in the latitude of the Canaries.

Isocrymes of 56° *and* 50° F.—Cape Hatteras, for a like reason, is the limit of the isocrymes of 56° and 50° as well as of 62°, there being no interval between them on the American coast. The line of 56° F. has a deep northward flexure between the meridians of 35° and 40° west, arising from the waters of the Gulf Stream, which here (after a previous east and west course, occasioned by the Newfoundland Bank, and the Polar current with its icebergs) bends again north-eastward, besides continuing in part eastward. The Polar current sometimes causes a narrow reversed flexure, just to the east of the Gulf Stream flexure. Towards Europe, the line bends southward, and passes to the south-west cape of Portugal, Cape St Vincent, or perhaps to the north cape of the Straits of Gibraltar. Vaillant, in the Bonite, found the sea-temperature at Cadiz in February, 49½° to 56° F. (9·7° to 13·4° C.), which would indicate that Cadiz, although so far south (and within sixty miles of Gibraltar), experiences at least as low a mean temperature as 56° F. for a month or more of the winter season. We have, however, drawn the line to Cape St Vincent, which is in nearly the same latitude. Between Toulon and Cadiz, the temperatures of the Mediterranean in February, according to Vaillant, was $55\frac{1}{2}$° to $60\frac{1}{4}$° F. (13·1° to 15·7° C.), and it is probable, therefore, that Gibraltar and the portion of the Mediterranean Sea east and north to Marseilles, fall within the *Temperate* Region, between the isocrymes of 56° and 62° F., while the portion beyond Sardinia and the coast by Algiers is in the *Warm Temperate* Region, between the isocrymes of 62° and 68° F.

The line of 50° F., through the middle of the ocean, has the latitude nearly of the southern cape at the entrance of the British Channel; but approaching Europe it bends downward to the coast of Portugal. The low temperature of $49\frac{1}{2}$° observed by Vaillant at Cadiz would carry it almost to this port, if this were the mean sea-temperature of a month, instead of an extreme within the bay. The line appears to terminate near latitude 42°, or six degrees north of the isocryme of 56°. This allows for a diminution of a degree Fahrenheit of temperature for a degree of latitude. A temperature as low as 61° F. has been observed at several points within five degrees of this coast in *July*, and a temperature of 52° F. in February. Vigo Bay, just north of 42° north, lies with its entrance opening westward, well calculated to receive the colder waters from the north; and at this place, according to Mr R. MacAndrew, who made several dredgings with reference to the geographical distribution of species, the Mollusca have the character rather of those of the British Channel than of the Mediterranean.*

Isocryme of 44° F.—This line commences on the west, at Cape Cod, where there is a remarkable transition in species, and a natural boundary between the south and the north. The cold waters from the north, and the ice of Newfoundland Banks, press the line close upon those of 50° and 56° F. But after getting beyond these influences, it rapidly rises to

* Rep. Brit. Assoc., 1850, p. 264.

the north, owing to the expansion of the Gulf Stream in that direction, and forms a large fold between Britain and Iceland; it then bends south again and curves around to the west coast of Ireland.

Isocryme of 35° F.—This line has a bend between Norway and Iceland like that of 44°, and from the same cause, —the influence of the Gulf Stream. But its exact position in this part has not been ascertained.

2. South Atlantic.—*Isocryme of* 74° F.—This line begins just south of Bahia, where Fitzroy found in August (the last winter month) a temperature of 74° to 75½° F. During the same month he had 75½° to 76½° F. at Pernambuco, five degrees to the north. Off Bahia, the temperature was two degrees warmer than near the coast, owing to the warm tropical current, which bends the isocryme south to latitude 17° and 18° and the cold waters that come up the coast from the south. The line gradually rises northward, as it goes west, and passes the equator on the meridian of Greenwich. Sabine, in a route nearly straight from Ascension Island, in 8° south, to the African coast under the equator, obtained in June (not the *coldest* winter month) the temperatures 78°, 77°, 74°, 72·8°, 72·5°, 73°, the temperature thus diminishing on approaching the coast, although at the same time nearing the equator, and finally reaching it within a few miles. These observations in June shew that the isocryme of 74° F. passes north of the equator. The temperatures mentioned in Maury's chart afford the same conclusion, and lead to its position as laid down.

Isocryme of 68° F.—On October 23 to 25, 1834, Mr D. J. Browne, on board the U.S. ship Erie, found the temperature of the sea, on entering the harbour of Rio Janeiro, 67½° to 68½ F. Fitzroy, on July 6, left the harbour with the sea-temperature 70½° F. Beechy, in August 1825, obtained the temperature 68·16° to 69·66° F. off the harbour. The isocryme of 68° F. commences therefore near Rio, not far south of this harbour. Eastward of the harbour, the temperature increases two to four degrees. In July, Fitzroy carried a temperature above 68° as far south as 33° 16′ south, longitude 50° 10′ west, the water giving at this time 68½° to 69½°

F. Beechey in August obtained 68° F. in 31° south, 46° west. The isocryme of 68° F. thus bends far south, reaching at least the parellel of 30°. It takes a course nearly parallel with the line of 74° F., as different observations shew, and passing just south of St Helena, reaches the African coast, near latitude 7° south. Fitzroy, on July 10 (mid-winter), had a sea-temperature of 68½° near St Helena; and Vaillant, in the Bonite, in September found the sea-temperature 68·7° to 69·26 F°.

Isocrymes of 56° *and* 50° F.—These two isocrymes leave the American coast rather nearly together. The former commences just north of the entrance of the La Plata. Fitzroy, in July 23 to 31, 1832, found the sea-temperature at Monte Video 56° to 58° F., and in August, 57° to 54½° F. These observations would lead to 56° F. as nearly the mean of the coldest month. The temperature 56° F. was also observed in 35° south, 53° west, and at 36° south, 56° 36′ west. But on July 10 and 13, 1833, at Monte Video, the sea-temperature was 46½° to 47½°, a degree of cold which, although only occasional, throws the line of 56° F. to the north of this place. The temperature near the land is several degrees of Fahrenheit lower than at sea three to eight degrees distant. East of the mouth of La Plata, near longitude 30° west, Beechey, in July 1828, found the temperature of the sea 61·86° F. So in April 23 to 29, Vaillant obtained the temperature 59·5° to 61·25° F. at Monte Video, while in 35° 5′ south, 49° 23′ west, on April 14, it was 66·2° F.; and farther south, in 37° 42′ south, 53° 28′ west, April 30, it was 64·4° F.; and in 39° 19′ south, 54° 32′ west, on May 1, it was 57¾° F.; but a little to the westward, on May 2, in 40° 30′ south, 56° 54′ west, the temperature was 48° F., an abrupt transition to the colder shore waters. Beechey, in 39° 31′ south, 45° 13′ west, on August 28 (last of winter), found the temperature 57·25° F., and on the 29th, in 40° 27′ south, 45° 46′ west, it was 54·20°; while on the next day, in 42° 27′ south, 45° 11′ west, the temperature fell to 47·83° F. These and other observations serve to fix the position of the isocryme of 56° F. It approaches the African coast in 32° south, but bends upward, owing to cold waters near the land. On

August 20, Vaillant, in 33° 43′ south, 15° 51′ east, found the temperature 56° F.; while on the 22d, in the same latitude, and 14° 51′ east (or one degree farther to the westward), the temperature was 57·74° F., being nearly two degrees warmer. At Cape Town, in June (latitude 34°), Fitzroy found 55° to 61° F., while on August 16, farther south, in 35° 4′ south, and 15° 40′ west, one hundred and fifty miles from the Cape, Vaillant found the temperature 59·26° F. The high temperature of the last is due to the warm waters that come from the Indian Ocean, and which afford 61° to 64° F. in August, off the south extremity of Africa, west of the meridian of Cape Town.

The isocryme of 50° F. leaves the American coast just south of La Plata; after bending southwardly to the parallel of 41°, it passes east nearly parallel with the line of 56° F. It does not reach the African coast.

Isocrymes of 44° *and* 35° F.—Fitzroy in August (the last winter month) of 1833, found the sea-temperature at Rio Negro (latitude 41° south) 48½° to 50° F. But during the voyage from the La Plata to Rio Negro, a few days before, a temperature of 44½° to 46° was met with; this was in the same month in which the low temperature mentioned above was found at Monte Video. The bend in the course north of the entrance to the La Plata is to some extent a limit between the warmer waters of the north, and the colder waters from the south; not an impassable limit, but one which is marked often by a more abrupt transition than occurs elsewhere along this part of the coast. The water was generally three or four degrees colder at Monte Video than at Maldonado, the latter port being hardly sheltered from the influence of the tropical waters, while Monte Video is wholly so. The exact point where the line of 44° F. reaches the coast is somewhat uncertain; yet the fact of its being south of Rio Negro is obvious. After leaving the coast, it passes north of 47½° south, in longitude 53° west, where Beechey, in July 1828, found the sea-temperature 40·70° F.

The line of 35° F. through the middle of the South Atlantic follows nearly the parallel of 50°; but towards South America it bends southward and passes south of the Falklands and Fuegia. At the Falklands, Captain Ross, in 1842, found the mean temperature of the sea for July, 38·73°, and for August, 38·10°; while in the middle of the Atlantic, on March 24, latitude 52° 31′ south, and longitude 8° 8′ east, the temperature was down to 34·3° F., and in 50° 18′ south, 7° 15′ east, it was 37° F.; March 20, in 54° 7′ south, on the meridian of Greenwich, it was 33·4° F. The month of March would not give the coldest temperature.

The temperature of the sea along the south coast of Fuegia sinks almost to 35°, if not quite, and the line of 35° therefore runs very near Cape Horn, if not actually touching upon Fuegia.

North Pacific Ocean.—*Isocryme of* 80° F.—The waters of the Atlantic in the warmest regions sink below 80° F. in the colder season, and there is therefore no proper Supertorrid Region in that ocean. In the Gulf of Mexico, where the heat rises at times to 85° F., it sinks in other seasons to 74° and in some parts, even to 72° F.; and along the Thermal equator across the ocean, the temperature is in some portions of the year 78°, and in many places 74°.

But in the Pacific, where the temperature of the waters rises in some places to 88° F., there is a small region in which through all seasons the heat is never below 80°. It is a narrow area, extending from 165° east to 148° west, and from 7½° north to 11° south. In going from the Feejees in August, and crossing between the meridians of 170° west and 180°, the temperature of the waters, according to Captain Wilkes, increased from 79° to 84° F., the last temperature being met with in latitude 5° south, longitude 175° west, and from this, going northward, there was a slow decrease of temperature. The ship Relief, of the Expedition, in October, found nearly the same temperature (83½°) in the same latitude and longitude 177° west.* But the Peacock, in January and February (*summer* months), found the sea-temperature 85° to 88° F., near Fakaafo, in latitude 10° south, and longitude 171° west. In latitude 5° south and the same longitude, on the 16th of January, the temperature was 84°;

* See, for these facts, Captain Wilkes' Report on the Meteorology of the Expedition.

in 3° south, January 10, it was 83° F.; on March 26, in 5° south, and longitude 175° east, the temperature was 86° F.; on April 10, in the same longitude, under the equator, at the Kingsmills, the temperature was 83½° F.; on May 2, at 5° north, longitude 174° east, 83½° F.; May 5, latitude 10°, longitude 169° east, 82° F. The fact that the region of greatest heat in the middle Pacific is south of the equator, as it has been laid down by different authors, is thus evident; the limits of a circumscribed region of hot waters in this part of the Pacific were first drawn out by Captain Wilkes.

Another Supertorrid region may exist in the Indian Ocean, about its north-western portion; but we have not sufficient information for laying down its limits.

Isocryme of 74° F.—At San Blas, on the coast of Mexico, Beechey found the mean temperature of the sea for December 1827, 74·63° F.; for January, 73·69° F.; for February, 72·40° F. The line of 74° F. commences therefore a degree or two south of San Blas. In the winter of 1827 on January 16 to 18, the temperature of 74·3° to 74·6° F. was found by Beechey, in 16° 4′ to 16° 15′ north, 132° 40′ to 135° west; and farther west, in the same latitude, longitude 141° 58′ west, the temperature was 74·83° F. West of the Sandwich Islands, near the parallel of 20° north, the temperature rises five degrees in passing from the meridian of 165° west to 150° east, and the isocryme of 74° F. consequently trends somewhat to the north, over this part of the ocean. Between the meridians of 130° and 140° east, the temperature of the sea is quite uniform, indicating no northward flexure; and west of 130° east, nearing China, there is a rapid decrease of temperature, bending the line far south. Vaillant, of the Bonite, found the sea of Cochin China, in latitude 12° 16′ north, 109° 28′ east, to have the temperature of 74·12° F.; and even at Singapore, almost under the equator, the temperature on February 17 to 21, was 77·54° to 79·34° F. The isocryme of 74° F. terminates therefore upon the south-eastern coast of Cochin China.

Isocryme of 68° F.—Off the Gulf of California, in 25° north, 117° west, Beechey obtained, for the temperature of the sea, on December 13, 65° F.; on December 15, in 23° 28′ north (same latitude with the extremity of the peninsula of California), 115° west, a temperature of 69·41° F. The line of 68° will pass from the extremity of this peninsula the temperature of the coast below, as it is shut off mostly from the more northern or cold waters, being much warmer. The temperature 69·41°, in the middle of December, is probably two and a half degrees above the cold of the coldest month, judging from the relative temperature of the latter half of December and the month of February at San Blas. Leaving California, the isocryme of 68° will therefore bend a little southerly to 22½°, in longitude 115° west. In 23° 56′ north, 128° 33′ west, Beechey, on January 11, found the temperature of the sea 67·83° F. The line of 68° passes north of the Sandwich Islands. The mean temperature of the sea at Oahu, in February 1827, was 69·69° F.

Near China this isocryme is bent far south. At Macao, in winter, Vaillant found the sea-temperature, on January 4, 59° F.; on January 5 to 10, 52·7° to 50° F.; January 11 and 12, 49·87° to 48·74° F.; January 13 to 16, 50·9° to 52·16° F.; and at Touranne in Cochin China, on February 6 to 24, the sea-temperature was 68° to 68½° F.; in 16° 22′ north, 108° 11′ east, on January 24, it was 67°; in 12° 16′ north, 109° 28′ east, it was 74·12° F. The very low Macao temperature is that of the surface of the bay itself, due to the cold of the land, and not probably, as the other observations shew, of the sea outside.

The line, before passing south, bends northward to the south-east shore of Niphon, which is far warmer than the south-east coast, along Kiusiu. In the Report of the Morrison's visit to Jeddo (*Chinese Repository* for 1837), a coral bottom is spoken of, as having been encountered in the harbour of Jeddo. According to Sieboldt (*Crust. Faun. Japon.*, p. ix.), the mean winter temperature (air) of Jeddo is 57° F.; while that of Nagasaki, although farther south, is 44° F.

Isocryme of 62° F.—On January 8, 1827, Beechey found in 29° 42′ north, 126° 37′ west, the temperature 62·75° F.; while on the preceding day, 32° 42′ north, 125° 43′ west, the sea-temperature was 60·5° F. Again, on December 11, in 29° north, 120° west, the temperature was 62·58° F.

Isocryme of 56° F.—At Monterey, on January 1 to 5, the sea-temperature, according to Beechey, was 56°; but the mean temperature of the sea for November 1 to 17 was 54·91°. In the Yellow Sea the January temperature is 50° to 56° F., and the line of 56° begins south of Chusan.

Isocryme of 50° F.—At San Francisco, from November 18 to December 5, 1826, Beechey found the mean sea-temperature to be 51·14° F., and off Monterey, in longitude 123° west, the temperature was 50·75° F., on December 6. But in December of 1826, the mean sea-temperature at San Francisco was 54·78° F.; and for November, 60·16° F. The line of 50° F. (mean of the coldest thirty consecutive days), probably leaves the coast at Cape Mendocino.

Isocrymes of 44° *and* 35° F.—Captain Wilkes found the temperature off the mouth of the Columbia River, through ten degrees of longitude, 48° to 49° F., during the last of April 1841. The isocrymes of 44° would probably reach the coast not far north of this place. The temperature on October 21, in the same latitude, but farther west, 147° west, was 52·08° F. On October 16, in 50° north, 169° west, the temperature was 44·91° F. According to some oceanic temperatures for the North Pacific, obtained from Lieutenant Maury, the sea-temperature off northern Niphon, in 41° north, and 142½° east, was 44° F., in March, shewing the influence of the cold Polar current; and in 42° north, and 149½° east, it was 43° F. The line of 44° hence bends southward as far as latitude 40° north, on the Japan coast.

Again in March, in 43° 50′ north, 151° east, the sea-temperature was 41° F.; in 44° 50′ north, 152° 10′ east, 39° F.; in 46° 20′ north, 156° east, 33° F.; in 49° north, 157° east, 33° F.; and at the same time, west of Kamtschatka, in 55° north, 153° east, 38° F.; in 55° 50′ north, 153° west, 38° F. The line of 35° consequently makes a deep bend, nearly to 45° north, along the Kurile Islands.

South Pacific.—*Isocrymes of* 74°, 68°, *and* 62° F.—The temperature of the sea at Guayaquil, on August 3, was found by Vaillant to be, in the river, from 70½° to 73½° F., and at the Puna anchorage, August 5 to 12, 74·7° to 75·2° F. But off the coast, August 15, in 2° 22 south, 81° 42′ west, the temperature was 69·8° F.; and the next day, in 1° 25′ south, 84° 12′ west, it was 70° F.; on the 17th, 1° south, 87° 42′ west, it was 71·28° F.; and on the 14th, nearer the shore of Guayaquil, in 3° 18′ south, 80° 28′ west, it was 78° F. Again, at Payta, one hundred miles south of Guayaquil, in 5° south, the sea-temperature was found by Vaillant, July 26 to 31, to be 60·8° to 61½° F. The isocryme of 74° F. consequently leaves the coast just north of the bay of Guayaquil, while those of 68° and 62° F. both commence between Guayaquil and Payta. Payta is situated so far out on the western cape of South America that it receives the cold waters of the south, while Guayaquil is beyond Cape Blanco, and protected by it from a southern current. At the Gallapagos, Fitzroy found the temperature as low as 58½° F. on the 29th of September, and the mean for the day was 62°. The average for September was, however, nearer 66°. The Gallapagos appear, therefore, to lie in the Warm Temperate Region, between the isocrymes of 62° and 68° F. Fitzroy, in going from Callao to the Gallapagos, early in September, left a sea-temperature of 57° F. at Callao, passed 62° F. in 9° 58′ north, and 79° 42′ west, and on the 15th, found 68½° F. off Barrington Island, one of the Gallapagos.

In the warm season the cold waters about the Gallapagos have narrow limits; Beechey found a sea-temperature of 83·58° on the 30th of March 1827, just south of the equator, in 100° west. But in October, Fitzroy, going westward and southward from the Gallapagos, found a sea-temperature of 66° F. at the same place; and in nearly a straight course from this point to 10° south, 120° west, found the sea-temperatures successively 68°, 70°, 70½° 72½°, 73½°, 74°; and beyond this, 75½°, 76½°, 77½° F., the last on November 8, in 14° 24′ south, 136° 51′ west. These observations give a wide sweep to the cold waters of the colder seasons, and throw the isocrymes of 74° and 68° F. far west of the Gallapagos. Captain Wilkes, in passing directly west from Callao, found a temperature of 68° F. in longitude 85° west; 70° F. in 95° west; and 74° F. in 102° to 108° west. These and other observations lead to the positions of the isocrymes of 74°, 68°, and 62°, given on the chart. The line of 74° passes close by Tahiti and Tongatabu, and crossing New Caledonia, reaches Australia, in latitude 25° S.

In mid-ocean there is a bend in all the southern isocrymes.*

Isocrymes of 56° *and* 50° F.—The temperature at Callao, in July, averages 58½° or 59° F. At Iquique, near 20° south, Fitzroy had 58° to 60° F., on July 14, 1835; and off Copiapo, in the same month, 56½° F. At Valparaiso, Captain Wilkes found a sea-temperature of 52½° F., in May; and Fitzroy, in September, occasionally obtained 48° F.; but generally 52° to 53°. Off Chiloe, Fitzroy found the temperature 48° to 51½° in July.

Indian Ocean.—*Isocrymes of* 74° *and* 68° F.—Off the south extremity of Madagascar, in 27° 33′ south, 47° 17′ east, on August 4, Vaillant found the temperature 69·26° F.; and in 29° 34′ south, 46° 46′ east, the temperature of 67·84° F.; off South Africa, August 12, in 34° 42′ south, 27° 25′ east, the temperature 63·5° F.; on August 14, in 35° 41′ south, 22° 34′ east, a temperature of 63·3° F.; while off Cape Town, two hundred miles to the west, the temperature was 50° to 54° F.

In the above review we have mentioned only a few of the observations which have been used in laying down the lines, having selected those which bear directly on some positions of special interest as regards geographical distribution.

The chart also contains the *heat-equator*,—a line drawn through the positions of greatest heat over the oceans. It is a shifting line, varying with the seasons, and hence there is some difficulty in fixing upon a course for it. We have followed mainly the chart of Berghaus; but we have found it necessary to give it a much more northern latitude in the western Pacific, and also a flexure in the western Atlantic, both due to the currents from the south that flow up the southern continents.

Vaillant, passing from Guayaquil to the Sandwich Islands, found the temperature, after passing the equator, slowly increase from 76° F., August 19, in 2° 39′ north, 91° 58′ west (of Greenwich), to 81·9° F., in August 31, 11° 15′ north, 107° 3′ west, after which it was not above 80° F. The same place

* See Observations by W. C. Cunningham, Amer. Journ. Sci. (2) xv. 66.

in the ocean which gave Vaillant 76° F., in August, afforded Fitzroy (4° north, 96° west), on March 26 (when the sun had long been far north), 82½° F. This fact shews the variations of temperature that take place with the change of season.

Remarks on the several Temperature Regions.

The form and varying breadth of the different regions, and the relations between the sea-temperatures of coasts in different latitudes which they exhibit, are points demanding special remark. The conclusions are of much interest, although some changes in the chart will undoubtedly be required by future researches.

Atlantic Torrid Region, between 74° F. *north, and* 74° F. *south.*—The form of this region is triangular, with the vertex of the triangle to the east. Its least width is four degrees of latitude; its greatest width between the extreme latitudes is forty-six and a half degrees. On the African coast it includes only a part of the coast of Guinea, and no portion is south of the equator. On the west it embraces all the West India Islands and reefs (excepting the Little Bahama), and the South American coast, from Yucatan to Bahia,—a fact that accounts for the wide distribution of marine species on the American side of the ocean.

Atlantic Subtorrid Regions, between 74° *and* 68° F.—The *North Subtorrid Region* of the Atlantic is about six degrees in its average width, which is equivalent to a degree of Fahrenheit to each degree in surface. It incloses within the same temperature limits a part of the east coast of Florida, between 24° and 27½° north, and a part of the African coast, between the parallels of 9° and 14½° north, the two related coasts differing ten degrees in latitude. The Bermudas, in latitude 33°, and the Cape Verdes, in 15½°, fall within this region.

The *South Subtorrid Region* has the same average width as the northern.

Taking the whole Atlantic Torrid or Coral-reef zone together, its width on the east is about twenty-one degrees, while on the west it extends between the parallels of 30° south and 34° north, a breadth of sixty-four degrees. As many species will thrive under the temperature of any part of the Torrid zone, the geographical range of such species in the Atlantic may be very large, even from Florida and the Bermudas on the north, to Rio Janeiro on the south, a range of which there are actual examples.

Atlantic Warm Temperate Regions, between 68° *and* 62° F.—The *northern* of these regions has a breadth of fourteen and a half degrees along the west of Africa, and about seven degrees along the United States, to the south of Cape Hatteras, off the Carolinas, Georgia, and Northern Florida. These shores and the Canaries are therefore in one and the same temperate zone.

The *southern* of these regions averages five degrees in width. The eastern limit on the African coast is sixteen to eighteen degrees to the north of the western on the South American coast.

Atlantic Temperate Regions, between 62° *and* 56° F.—The *north* Temperate Region is but a narrow strip of water on the west, terminating at Cape Hatteras, and having no place on the coast of the United States. To the east it widens, and embraces the Azores, and the African coast along Morocco, together with the Straits of Gibraltar, and a large part of the Mediterranean. Madeira lies upon its southern limit. It is, therefore, natural that the same species should occur at the Azores, Madeira, and on the African coast, and be excluded wholly from the Atlantic coast of Europe. This, according to Prof. Forbes, is the fact with the *Littorina striata*, besides other species. The coasts of Portugal and the Azores are in different regions.

The *South* Temperate Region extends to Maldonado at the mouth of the La Plata, from near the parallel of 30°; along the African coast it reaches over more than twice the number of degrees of latitude, to within five degrees of Cape Town.

Atlantic Subtemperate Regions, between 56° *and* 50° F.—The *northern* of these regions, like the preceding, can not be distinguished on the coast of the United States, as the lines of 50° and 56° F. with 62° fall together at Cape Hatteras. On the eastern side of the Atlantic it occupies the coast of

Portugal to latitude 42° north, having a width of five degrees. It thus corresponds on this coast to the so-called Lusitanian Region.

The *southern* includes the mouth of the La Plata on one side, and on the other the coast near Cape Town, beyond which it extends to the Cape of Good Hope, or rather to Cape Lagulhas.

Atlantic Cold Temperate Regions, between 50° *and* 44° F. —The coast from Cape Cod to Cape Hatteras, belongs to the *Northern* Cold Temperate Region. Passing easterly, this region is but a narrow line of water for thirty degrees of longitude, after which it expands, and finally terminates between Western Ireland and latitude 42° on the Spanish coast. The British Channel, the Bay of Biscay, and probably Vigo Bay, Spain, are within the limits of this region.

The *southern* embraces the coast of South America, along by Rio Negro, for about five degrees, and passes wholly to the south of Africa.

Atlantic Subfrigid Regions, between 44° *and* 35° F.—The coast of Massachusetts, north of Cape Cod, of Maine and Newfoundland, and all Northern Britain, the Orkneys, Shetlands, and Faroe Islands, pertain to the *northern* Subfrigid Region; while the *southern* includes the Falklands, Southern Patagonia, and Fuegia.

Atlantic Frigid Regions, beyond 35° F.—Greenland, Iceland, and Norway are within the *northern* of these regions, and the South Shetlands, Sandwich Land, and South Georgia, within the *southern.*

Pacific Regions.—A comparison of the regions of the Atlantic and Pacific, and especially of the limits of those commencing at the South American coasts, brings out some singular facts.

The *Torrid* region of the Pacific, near the American coast, embraces only seventeen and a half or eighteen degrees of latitude, all but one of which are north of the equator; while that of the Atlantic covers a long range of coast, and reaches to 15° south. The south *Subtorrid* region has a breadth of about three degrees on the Peruvian coast, reaching to 4° south, or probably to Cape Blanco, while that of the Atlantic extends to Rio Janeiro, in 24° south. The *Warm Temperate* region, if at all found north of Cape Blanco, $4\frac{3}{4}$° S., has a breadth of less than a degree, while that of the Atlantic extends to Rio Grande, in 33° south. The next, or *Temperate* Region, has a longer range on the South American coast, extending to Copiapo, in $27\frac{1}{2}$° south, and the Atlantic region corresponding goes to Maldonado, in 35° south. The *Cold Temperate* regions of the two oceans cover nearly the same latitudes.

On the North American coast at Cape Hatteras, the three isocrymes 62°, 56°, and 50° F., leave the coast together; and in the Pacific, on the South American coast, there is a similar *node* in the system of isocrymes, the three, 74°, 68°, and 62°, proceeding nearly together from the vicinity of Cape Blanco.

Viewing these regions through the two oceans, instead of along the coasts, other peculiarities no less remarkable are brought out. The average breadth of the *South Torrid* region in the Pacific, is more than twice as great as that of the same in the Atlantic; and the most southern limit of the latter is five degrees short of the limit of the former in mid-ocean. So also the *Subtorrid* region, at its greatest elongation southward in the Atlantic, hardly extends beyond the mean course of the line of 68° F. in the Pacific, and the average breadth of the former is but two-thirds that of the latter. The same is true to an almost equal extent of the Warm Temperate and Temperate Regions.

The breadth of the Torrid Region of the Pacific to the eastward, where narrowest, is about six degrees; and to the westward, between its extreme limits, forty-nine degrees. The Torrid zone or Coral-reef Seas, in the same ocean, has a breadth near America of about eighteen degrees, and near Australia and Asia, of sixty-six degrees.

New Zealand lies within the Subtemperate and Cold Temperate regions, excepting its southern portion, which appears to pertain, like Fuegia, to the Subfrigid. Van Diemen's Land, exclusive of its northern shores, is within the Cold Temperate.

Other particulars respecting the temperature regions through the Pacific will be gathered from the chart.

Indian Ocean Regions.—The Torrid Region covers the larger part of the Indian Ocean, including all north of the equator, and embracing the larger part of Madagascar. The Subtorrid extends just beyond Port Natal on the African coast (four degrees of latitude north of Cape Town), where there are coral reefs, and also covers the northern part of the Red Sea. The Warm Temperate and Temperate regions each claim a part of the South African coast, and the latter terminates at Cape Lagulhas.

It hence follows that Port Natal, in latitude 30° south, the Hawaiian Islands, and Bermudas, lie within regions of the same name; while Cape Town, in latitude 34° south, is in a like region with northern New Zealand, Valparaiso, the Atlantic shores of Portugal, and the sea between Cape Hatteras and Cape Cod.

The areas of the Torrid, Temperate, and Frigid zones of ocean temperature, either side of the equator, considering 27° as the normal limit between the first two of these zones, and 56° the limit between the Frigid and Temperate, are as follow :—

Torrid zone,	33,711,200	square miles (geographical)
Temperate zone,	27,849,500	,, ,,
Frigid zone,	12,694,700	,, ,,

It is hence seen that the Temperate zone, although two degrees wider than the Torrid, has not as large a surface. The species of marine life, if distributed equally over the two, would, therefore, be one-fifth more numerous in the Torrid zone than in the Temperate, unless the extent of ocean and coast-line were far greater in the Temperate than in the Torrid zone, which is not the case. The ocean in the southern Temperate is much more extensive than that of the southern Torrid; but the coast-line is far less extensive in the former, as it does not abound in islands like the Torrid zone.* It is difficult to fix upon exact ratios, and we do not attempt it.

The range of temperature is far greater in the Temperate

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* The following table gives very closely the surface of the zones in square geographical miles, for every 2½ degrees of latitude to the parallel of 60° : it is deduced from a larger table by Berghaus, in his Länder und Volker-kunde,

zone than in the Torrid, it being 20° F. in the latter, and 33° F. in the former; and this should be a cause of a greater variety of genera in the latter for the same number of species.

In the Torrid zone the *Subtorrid* Region has nearly one-third the surface of the *Torrid* Region, and not one-fourth as much coast-line, facts which should be regarded in comparing the number of species of the two.

We add here a few brief remarks, in a popular way, on the origin of the peculiar forms and positions presented by the isothermal lines of the ocean. The great currents of the globe are admitted to be the causes that produce the flexures and modify the courses of these lines. These currents are usually of great depth, and consequently the deflecting land will be the deeply seated slopes off a coast, beyond ordinary soundings.

The *eastern* coasts of the continents either side of the equator feel the influence of a warm equatorial current, which flows westward over each ocean, and is diverted north and south by the coasts against which it impinges, and more or less according to the direction of the coast.

The *western* coasts of the continents, on the contrary, receive a strong extra-tropical or polar current. In the southern oceans, it flows from the westward, or southward and westward, in latitudes 45° to 65° south, and is brought to the surface by the submarine lands or the submarine slopes of islands or continents; reaching the continents of Africa

i. 47. The first is the zone from the equator to the parallel of $2\frac{1}{2}$°, the second, from $2\frac{1}{2}$° to 5°, and so on.

$2\frac{1}{2}$°	3,239,296	$32\frac{1}{2}$°	2,769,696
5	3,232,800	35	2,693,760
$7\frac{1}{2}$	3,220,496	$37\frac{1}{2}$	2,612,688
10	3,202,048	40°	2,526,624
$12\frac{1}{2}$	3,177,472	$42\frac{1}{2}$	2,435,776
15	3,146,912	45	2,340,256
$17\frac{1}{2}$	3,110,320	$47\frac{1}{2}$	2,241,280
20	3,067,808	50	2,136,128
$22\frac{1}{2}$	3,019,472	$52\frac{1}{2}$	2,027,840
25	2,962,176	55	1,915,696
$27\frac{1}{2}$	2,905,632	$57\frac{1}{2}$	1,767,168
30	2,840,368	60	1,680,704

The zone from 60° to 70° has the area, ... 5,466,992
" 70 to 80 " " . . . 3,350,064
" 80 to 90 " " . . . 1,128,144

and South America, it follows along the western coasts towards the equator. The same current, being divided by the southern cape of America, flows also with less volume up the eastern coast, either inside of the warmer tropical current, or else on both sides of it. In the Northern Seas the system of polar currents is mainly the same, though less regular; their influence is felt on both eastern and western coasts, but more strongly on the *eastern*. In the Atlantic the latter reduces the temperature of the waters three or four degrees along the north coast of South America, as far nearly as Cape St Roque.

The cold currents are most apparent along the coasts of continents and about islands, because they are here brought to the surface, the submarine slopes lifting them upward as they flow on. The limits of their influence towards the equator depends often on the bend of the coast; for a prominent cape or a bend in the outline will change the exposure of a coast from that favourable to the polar current to that favourable to the tropical, or the reverse. Thus it is at Cape Hatteras, on the coast of the United States; Cape Verde, on Western Africa; Cape Blanco, on Western South America, &c.

These are important principles modifying the courses of the oceanic isothermal lines. We may now proceed to the application of them which the best authors afford us, and to some conclusions flowing from the facts.

In the Atlantic, the warm tropical current flowing westward is trended somewhat northward by the northern coast of South America, and still more so by the West India Islands, and thus it gradually curves around to parallelism with the coast of the United States. But south of Newfoundland, either wholly from the influence of the colder current with which it meets, or in part from meeting with submarine slopes that serve to deflect it, it passes eastward, and afterwards, where it is again free to expand, it spreads both eastward and north-eastward. The flexures in the isocrymes of 74° and 68° F., near the United States coast, thus have their origin. For the same reason the line of 56° F. is nearly straight, till it reaches beyond the influence of the

Newfoundland Banks, and then makes its Gulf Stream flexure. The line of 44° F., for the same reason—the spreading of the Gulf Stream waters—diverges far from the equator in its easterly course, and even rises in a long loop between Great Britain and Iceland.

The cold currents flowing down the eastern coast of America bend the isocrymes far south close along the coast, and make a remarkable southern flexure in the isocrymes of 68° F., outside of the Gulf Stream flexure. So on the western coast of Britain, the isocryme of 44° F. has a deep southern flexure, for a like cause.

The waters of the tropical current gradually cool down in their progress, through the influence of the colder waters which they encounter; and along the isocryme of 62° they have in the colder seasons a common temperature with that of the ocean, so that the course of the Gulf Stream is but faintly marked in it. And also in the western half of the region covered by the isocryme of 56°, the colder and warmer waters have reached this as a mean temperature. Owing to the influence of the polar current on the northern coast of South America, the equator of heat lies at a distance from the land.

Up the western coast of Africa flows the cold current from the south and west, bending upward all the isocrymal lines; and passing north of the equator, it produces a large southern bend, off the coast of Africa, in the northern isocryme of 74°, outside of the warm current flexure from the coast of Guinea, and also a large northern flexure in the heat-equator.*

The Atlantic tropical current also flows in part down the eastern coast of South America, giving a deep flexure to each of the isocrymes, besides making these lines to diverge from the equator, through all their length. Again, the polar current passes northward nearer the coast-line, bending far back the western extremity of each of the isocrymes.

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* Along the ocean, near Africa, south and south-east of the Cape Verdes, Captain Wilkes found a current setting to the northward for much of the time until passing the equator.

In the Pacific the *tropical* currents shew their effects near the coasts of New Holland and China, in a gradual divergence of the lines from the equator. The ranges of islands forming the Tarawan, Radack, and Ralick groups, appear to divert the current northward in that part of the North Pacific, and consequently the isocrymal lines bend northward near longitudes 170° west and 180°; and near Niphon that of 68° shews a still greater northern flexure.

The influence of the *extra-tropical* currents in this ocean is remarkably great. The southern flows from the west and south, bending upward the line of 56° F. along the South American coast, producing at Valparaiso at times a sea-temperature of 48° F. Still farther north it throws the line of 68° F. even beyond the equator and the Gallapagos; and that of 74° F. nearly 1500 miles from the coast, and 400 north of the equator. The line of 62° F. reaches even beyond Payta, the sea-temperature at this place being sometimes below 61°.

The north polar current produces the same result along the eastern coast of Asia as on the eastern of America. The isocryme of 74° F. is bent southward from the parallel of 23° to 12° 30′ north, and that of 68° F. from 34° to 15° north; and the latter deflection is even longer than the corresponding one in the Atlantic. The trend of the coast opens it to the continued action of this current until the bend in the outline of Cochin-China, below which the cold waters have less influence, although *still shewing some effect upon the heat-equator*. The isocryme of 44° is bent southward to Niphon by the same cold waters, and from this part of the Northern Pacific the current appears to flow mostly between the islands of Japan and the continent.

In the Indian Ocean the effects of the tropical current, as it flows westward, are apparent in the southern deflection of the several isocrymes. The trend of the coast favours a continuation of the current directly along the coast, and consequently its modifying influence on the sea-temperature reaches almost to Cape Town on the coast, and passes even beyond it at sea, crrrying 56° F. to the meridian of 15° east.

By comparing the regions of the different oceans, north and south of the equator, we may arrive at the mean position of the several isocrymes, and thereby discover, on a grander scale, the influence of the various oceanic movements.

For the purpose of reaching mean results, the Middle Pacific is the most favourable ocean for study. This is apparent in its greater extent, and the wide distance between the modifying continents; and also no less in the greater actual regularity of the isocrymes.

We thence deduce, that the mean position of the isocryme of 74° F. is along the parallel of 20°, this being the average between the means for the North and South Pacific. In the same manner we infer that the mean position of the isocryme of 68° F. is along the parallel of 27°.

The southern isocrymes of 56° and 62° F. are evidently thrown into abnormal proximity by the cold waters of the south. This current flows eastward over the position of the isocryme of 44° F., and consequently in that latitude has nearly this temperature, although colder to the south. Hence it produces little effect in deflecting the line of 44° F.; moreover the line of 50° F. is not pushed upward by it. But the lines of 56° and 62° F. are thrown considerably to the north by its influence, and the Warm Temperate and Temperate Regions are made very narrow. With these facts in view, we judge, from a comparison of the North and South Pacific lines, that the mean position for the isocryme of 62° F. is the parallel of 32°; and for 56° F., the parallel of 37° F.; for the isocryme of 50° F. the mean position is nearly the parallel of 42°; for 44° F. the parallel of 47°; for 35° F. the parallel of 56°. There is thus a mean difference of five degrees of latitude for six degrees of Fahrenheit, excepting near the equator, and between 35° and 44° F. These results may be tabulated as follows:*—

* We may hence deduce the temperature of those isocrymes to which the parallels of latitude for every five degrees would normally correspond. They would be for 20°, 74° F.; for 25°, 70° F.; for 30°, 64·4° F.; for 35°, 58·4° F.; for 40°, 52·4° F.; for 45°, 46·4° F.; for 50°, 41° F.; for 55°, 36° F.; for 60°, 31° F.

Isocryme of 80° F., . .	Parallel of 6°
,, 74 ,, . .	,, 20
,, 68 ,, . .	,, 27
,, 62 ,, . .	,, 32
,, 56 ,, . .	,, 37
,, 50 ,, . .	,, 42
,, 44 ,, . .	,, 47
,, 35 ,, . .	,, 56

Using these results as a key for comparison, we at once perceive the great influence of the oceanic movements on climate, and on the geographical distribution of marine life.

The polar or extra-tropical current of the Southern Atlantic has a more northward course in mid-ocean than that of the Pacific. It consequently bears up the isocryme of 35° F. to the parallel of 50°, that is, six degrees above the mean. The effect on the other isocrymes of the Atlantic is very remarkable. We perceive, in the first place, that the *most southern* point of each of these isocrymes is not far from the mean position of the same isocrymes in the Pacific, while the most northern point of each is ten to twenty-five degrees further north. Taking the position of the isocrymes of 68° and 74° F., where they cross the meridian of 15° west, as the mean position for this ocean, we find that the former is eight degrees in latitude farther north than 68° F. in the South Pacific; and the mean for the latter is in 7° south, while for the same in the Pacific it is 20° south, making a difference of thirteen degrees. The effect of the cold southern waters is consequently not along the African coast alone, but pervades the whole ocean. It is hence obvious, how utterly untenable the common notion that the tropical current from the Indian Ocean is the same which flows up the west African coast. With a temperature of 56° south of Cape Town, it would be wholly incapable of causing the great deflections for the whole South Atlantic which have been pointed out. It combines with the cold current, but does not constitute it. The facts thus sustain the opinions long since brought forward by the distinguished meteorologist Mr Wm. C. Redfield, that the currents flowing north along the African and

South American coasts are alike antarctic or cold temperate currents.*

We may now turn to the North Atlantic. In this part of the ocean the mean positions of the isocrymes of 74° and 68° F. are near the normal positions deduced from the Pacific. The line of 62° F. is in a somewhat higher latitude, the mean position, excluding the eastern and western deflections, being near the parallel of 36°. The line of 56° F. has the parallel of 42½° north for its mean position over the middle of the ocean, which is five and a half degrees above the normal in the Pacific. The line of 50° has in the same manner, for its mean position over mid-ocean, the parallel of 47½°, or again five and a half degrees above the normal position in the Pacific. The line of 44° F. may be considered as having for its mean position the parallel of 52° north, while it rises to 60° north. The lines in the North Atlantic above that of 68° average about five degrees higher in latitude than the mean normal positions, while 68° and 74° have nearly the same places as in the Pacific. There is hence a great contrast between the Pacific, South Atlantic, and North Atlantic Oceans. This is seen in the following table containing these results:—

	Normal, deduced from Pacific.	Mean position in South Atlantic.	Mean position in North Atlantic.
Isocryme of 74° F.,	20°	7° S.	21° N.
" 68	27	19	28
" 62	32	29	36
" 56	37	36	42½
" 50	42	39	47½
" 44	47	44	52 (max. 60° N.)
" 35	56	50	61

The influence of the warm tropical waters in the North Atlantic lifts the isocrymes of 74° and 68° as they approach the coast of America, while the same lines are depressed on the east by the colder northern currents. Moreover, north of 68° the whole interior of the ocean is raised four to five degrees in temperature above the normal grade, by the same waters spreading eastward; and between Great Britain and

* American Journal of Science, xlv., 299, 1843.

Iceland, the temperature is at least ten degrees warmer than in the corresponding latitude of the South Pacific, and thirteen or fourteen degrees warmer than in the same latitude in the South Atlantic.*

The influence of so warm an ocean on the temperature of Britain, and on its living productions, animal and vegetable, is apparent, when it is considered that the winds take the temperature nearly of the waters they pass over. And the effects on the same region that would result from deflecting the Gulf Stream in some other direction, as brought out by Prof. Hopkins† and others, and substituting in the Northern Atlantic the temperature of the Southern Atlantic, is also obvious, without further illustration. The discussion of these subjects would be foreign to the topic before us.

The subdivision of the oceans into Temperature Regions affords a convenient means of dividing off the coasts into *Zoological Provinces.* A comparison of the facts afforded by the distribution of Crustacea, with the positions and extent of the provinces thus deduced, shew that they are natural, and may in general be well characterized.

Zoological Provinces have been considered by some as centres of creation, and therefore of diffusion, for groups of species. But such kinds of centres we fail to distinguish in any part of the globe. Each species may have had its one point of origin and single centre of diffusion in many and perhaps the majority of cases: but however the fact may be, we have no *evidence* for asserting that particular regions were without life, and were peopled by migration from specific and predetermined centres; for if there were such centres of diffusion, there are at present no means by which they may be ascertained. The particular temperature region in which a

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* Ross, in his antarctic voyage, found the sea-temperature in 60° south and 3° west, 31½° F., in the month of *March;* at the South Shetlands, 61° south, the sea-temperature was 31° to 35° in January (midsummer); and in the same latitude, and 45° west, it was 30·1° in February.

† Quarterly Jour. Geol. Soc., vol. viii., p. 56, and Amer. Jour. Science, 1853, vol. xv.

species was created may be ascertained by observing which is most favourable for its development; and by this course of investigation, we may find that almost every different locality has some species for which it is especially fitted. We may thus shew, as far as reason and observation can do it, that all regions, as a general thing, have had their own special creations.

We rather look to climatal influences, in all their various kinds, directly and indirectly exerted, and united with height or depth of site, and other geographical conditions, as giving limits to Zoological Provinces; and as regards marine animals, ocean temperature is the more prominent of these influences. Under temperature, the limits or extremes are to be considered as well as the mean, and also the varying action of currents which induce the changes, especially those occasional extreme results which are of decennial rather than annual occurrence.

How far geological changes, by subsidence and elevation, have varied the distribution of the present races of animals, or given limits to zoological regions, is a point yet uninvestigated. The conclusions that have been derived from this source are mostly of a hypothetical character, and are to be received with distrust without a larger supply of evidence. It is easy to meet a difficulty by the supposition of a former union by dry land of regions now separate; but it appears to us that better evidence is needed on such a point, than those derived from the zoological fact which is to be explained.

Along the various coasts, prominent *capes* are in general the limits of Zoological Provinces; and this fact is well shewn in the chart of ocean temperature. They are, as we have explained, the points where the cold or warm currents are turned off from a coast, and where, therefore, there is a sudden transition in the temperature. A striking example of this has been pointed out on both the eastern coast of North America, and western of South America, where several isocrymes meet, forming a kind of nodal point;—viz., Cape Hatteras, the meeting point of the isocrymes of 62°, 56°, and 50°, and Cape Blanco, the meeting point of 68°, 62°, and (nearly) 74°. So also the east cape of East Australia, is the point of meeting of the isocrymes of 74° and 68°. At the south extremity of Africa, on the west coast of Asia, there are approximations to the same fact. Cape Cod, the south-east cape of New England, is a marked point in zoological geography, and the termination of the isocryme of 44° F.; and the North Cape of the La Plata, inside of Maldonado, is another.

We proceed to give an enumeration of the several Zoological Provinces, to which we are led by the temperature regions adopted. It should be again observed, that the isocryme of 68° is the grand boundary of coral reefs, and of the larger part of the zoological life connected with them, and that the *Torrid Zone* and *Coral-reef Zone* of oceanic temperature are synonymous terms.

We mention also the extent of the Provinces; and it will be found, that although seemingly numerous, few of them are under 500 miles in length, while some are full 4000 miles.

For zoological reasons which are explained in another place,* and which may be the subject of another communication to this Journal, we adopt for *Marine* Zoological Geography, three grand divisions of the coasts of the globe. 1. The *American* or *Occidental*, including East and West America; 2. The *Africo-European*, including the coasts of Europe and Western Africa; and, 3. The *Oriental*, including the coasts of Eastern Africa, East Indies, Eastern and Southern Asia, and Pacific. Besides these, there are the *Arctic* and *Antarctic* Kingdoms, including the coasts of the frigid zones, and in some places, as Fuegia, those of the extreme temperate zone. We add here, only in general terms, that there is a remarkable similarity in the genera of Eastern and Western America, and an identity of some few species; that the coast of Europe and Eastern Africa widely differ in Crustacea from either the American or Oriental; that the species of the Oriental division have a great similarity in genera, and that numerous species of Crustacea of Eastern Africa are identical with those of the Pacific. We pass by, for the present, the details on these points.

* The author's Report on Crustacea.

We also omit the zoological characters of the Provinces here enumerated. Several of these Provinces are identical with those proposed by Milne Edwards, Prof. E. Forbes, and others; and, as far as possible, the names heretofore used are retained.

I. OCCIDENTAL KINGDOM.

A. Western Section.

1. *Torrid or Coral-reef Zone.*

Provinces.	Limits.	Length in Miles.
1. Panamian, (torrid) . .	1° S. to 17½° N. . .	1600
2. Mexican, Province, (N. subtorrid)	17½° N. to Californ. Penin.	600
3. Guayaquil ,, (S. subtorrid)	1° S. to Cape Blanco, 4¾° S.	200

2. *North Temperate Zone.*

4. Sonoran, (warm temperate) .	Penin. Californ. to 28½° N.	550
5. Diego* or Jacobian, (temperate)	28½° N. to 34½° N. . .	450
6. Californian, (subtemperate) .	34½° N. to C. Mendocino	480
7. Oregon, (cold temperate) .	C. Mendocino to Puget's Sound (?) . . .	480
8. Pugettian, (subfrigid) . .	Puget's Sound to 55° or 56°	1200

3. *South Temperate Zone.*

9. Gallapagos, (warm temperate)	Gallapagos.	
10. Peruvian, (temperate) . .	C. Blanco to Copiapo, 27½° S.	1500
11. Chilian, (subtemperate) .	27½° S. to 38° S. . .	700
12. Araucanian, (cold temperate)	38° to 49° or 50° S. .	900
13. South Patagonian, (subfrigid)	50° S. to Magellan Straits.	

B. Eastern Section.

1. *Torrid Zone.*

1. Carribbean, (torrid) . .	Key West and N. Yucatan to 1° S. of Bahia . .	4000
2. Floridan, (N. subtorrid) .	Key West to 27° N. .	200
3. Brazilian, (S. subtorrid) .	15° S. to 24° S. . .	600

2. *North Temperate Zone.*

4. Carolinian, (warm temperate)	27° N. to Cape Hatteras	600
5. Virginian, (cold temperate) .	Cape Hatteras to Cape Cod	650
6. Arcadian, (subfrigid)† . .	Cape Cod to E. Cape of New-foundland . .	900

3. *South Temperate Zone.*

7. St Paul,‡ (warm temperate) .	24° S. to 30° S. . .	480
8. Uraguaian, (temperate) .	30° S. to N. Cape of La Plata	360
9. Platensian, (subtemperate) .	Mouth of La Plata.	
10. North Patagonian, (cold temperate)	S. Cape of La Plata to 43° S.	500
11. South Patagonian,§ (subfrigid)	43° S. to Magellan Straits	700

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* May possibly be united conveniently to the Sonoran.

† Changed from Nova-Scotian in the Report on Crustacea.

‡ The St Paul province may perhaps be united with the Uraguaian.

§ The South Patagonian is made to include both the eastern and western sides of this portion of the continent; but a division of the two may hereafter be found to be required.

II. AFRICO-EUROPEAN KINGDOM.

1. *Torrid Zone.*

Provinces.	Limits.	Length in Miles.
1. Guinean, (torrid)	5° N. to 9° N.	1200
2. Verdensian, (N. subtorrid)	9° N. to 14½° N., including the Cape Verde Islands	1000
3. The Biafrian, (S. subtorrid)	5° N. to 7° or 8° S., including Ascension and St Helena	900

2. *North Temperate Zone.*

4. Canarian, (warm temperate)	14½° N. to 28° or 29° N., including the Canaries	1000
5. Mediterranean, (temperate)	29° N. to Cape St Vincent, with Mediterranean, excepting some of its northern coasts, and including Madeira and Azores.	
6. Lusitanian, (subtemperate)	Cape St Vincent to 42° N.	300
7. Celtic, (cold temperate)	42° N. to Scotland	1000
8. Caledonian, (subfrigid)	N. Scotland, Shetlands, Forroe, &c.	

3. *South Temperate Zone.*

9. Angolan, (warm temperate)	7° S. to 13° S.	360
10. Benguelan, (temperate)	13° S. to 28° S.	900
11. Capensian, (subtemperate)	28° S. Cape Agulhas	450
12. Tristensian, (cold temperate)	Tristan d'Acunha.	

III. ORIENTAL KINGDOM.

I. African Section, or East Coast of Africa and Neighbouring Islands.

1. Abyssinian, (torrid)	26½° S. to 21° or 22° in Red Sea, including larger part of Madagascar & Islands north	3500
2. Erythrean, (N. subtorrid)	Northern third of Red Sea, about	300
3. Natalensian, (S. subtorrid)	26½° S. to 31° S., with southern Madagascar and Isle of France.	
4. Algoan, (warm temp. and temp.)	31° S. to Cape Lagulhas	550

II. Asiatic Section.

1. *Torrid Zone.*

1. Indian, (torrid)	East India Islands, N. Australia, Southern Asia, to 12½° N. on Cochin China.	
2. Liukiuan, (N. subtorrid)	12½° N. to 15° N., with Formosa, Loochoos, S.S.E. shore of Japan.	
3. Endrachtian, or W. Australian, (S. subtorrid)	W. Australia 22° S. to 26½° S.	300

2. *North Temperate Zone.*

4. Tonquin, (warm temperate)	15° N. to 25° N., (Gulf Tonquin).	
5. Chusan, (subtemperate)	25° N. into Japan Sea.	
6. Niphonensian, (cold temperate and subtemperate)	East coast of Niphon, to 40° N.	

Provinces.	Limits.
7. Saghalian, (subfrigid) . .	Coast of Japan Sea, part of Western and Northern Niphon, Saghalian, Yeso, &c.
3. South Temperate Zone.	
8. Cygnian, or Swan R., (warm temp.)	W. Australia, 26½° S. to SW. Cape.
9. Flinders, (temperate) . .	Southern coast of Australia.
10. Moreton, (warm temp. and temp.)	E. Australia, 26½° S. to 31° S.
11. Bass, (subtemperate) . .	E. Australia, 31° or 32° S. to Van Diemen's Land.
12. Tasmanian, (cold temperate) .	Van Diemen's Land.
III. Pacific Section.	
1. Torrid Zone.	
1. Polynesian, (torrid) . .	Pacific Islands of Torrid Region.
2. Hawaiian, (N. subtorrid) .	Hawaiian range of Islands.
3. Raratongan, (S. subtorrid) .	Hervey Islands and others of South Subtorrid Region.
2. South Temperate Zone.	
4. Kermadec, (warm temp. and temp.)	Kermadec Islands, &c.
5. Wangaroan, (subtemperate) .	Northern New Zealand.
6. Chatham, (cold temperate) .	Middle N. Z. to 46° S. and Chatham I.

The Arctic Kingdom includes, (1.) The *Norwegian*, north of the Atlantic; (2.) The *Kamtschatcan*, north of the Pacific; (3.) The *North Polar*. The Antarctic Kingdom includes, (1.) The *Fuegian*, Fuegia and Shetlands, &c.; (2.) The *Aucklandian*, Auckland and southern extremity of New Zealand; (3.) The *South Polar*.

On the Temperatures of Running Streams during periods of Frost. By Richard Adie, Esq., Liverpool.

The steady frost which prevailed at the close of the last and commencement of the present year, offered to me a favourable opportunity of testing the temperatures of several streams. These I found so exactly regulated to the freezing point of water, that I have been led to reflect on the nature of the process which gives this uniformity, and which I now propose to endeavour to trace, in order to shew that it forms the basis for the explanation of the phenomenon of ice in the beds of rivers, of which those I have recently examined offered abundant specimens.

In this Journal, vol. 43, p. 243, I published an account of some ground ice examined in a small rivulet 12 miles north of Liverpool; at the same time I described the rapid formation of numberless small ice pillars I had witnessed on the sides of the Pentland hills near Edinburgh, after a single night's frost, from the water oozing gradually to the surface as it descended the hill. Captain Scorseby, in vol. 48, p. 1, of this Journal, has given a similar description of ice pillars formed under like circumstances. And I find in conversing with those resident in hilly districts, that they are familiar with them. Around Liverpool, in delfs, I have often noted, during periods of frost, large accumulations of ice on the wall-sided surfaces of the sandstone which bound these delfs; where the conditions for freezing are not favourable; the walls being vertical and very confined, screen the parts, from radiation to the open sky. Yet, in confined situations, where the water oozes slowly to the surface, masses of ice collect which much exceed in thickness that on the adjacent ponds open to the sky and winds. While on a recent journey among the hills of Westmoreland, Dumfries and Lanark shires, I saw masses of ice formed from the water coming slowly to the atmosphere, where it spreads over the surface of the ice already made in a thin film, so as to be very favourably placed for freezing. This water which oozes to the surface on the rocks and hillsides forms a chief source of supply of the rivulet, which, in a hilly country every valley has; presently these rivulets are joined together to make a river which is hastening to the sea. In such districts, then, the sources of streams are extremely active in ice-making, and the water in its passage downwards has to bathe a large superficies of this material, which it must continue to melt until the stream is cooled down to a freezing temperature; a process which appears to go on with celerity after frosty weather has formed ice on the surface of the quieter parts of a running stream.

During frost, a walk along the bank of a river shews in various ways how the current of a stream acts favourably for forming ice. The water in rivers is usually then low for the winter season; the action of the frost checking the supply. The stream occupies only a portion of its bed—ice soon collects at the edges and on the surface, at places where the water runs slowly or is shallow, this ice offers an impediment to the current, and thus often sends some of the water of the stream over the surface of a portion of the ice,—a position most favourable for its being frozen. In the river Eden, near Carlisle, I saw specimens of ice of this kind; at one of the arches of the bridge there was a large table of submerged surface-ice sunk one foot below the surface, and rent up the centre. In the river Esk, near Musselburgh, I saw a sheet of surface-ice at the edge of the stream, frozen on the top of the gravel, and covered with water one to two inches deep, in which a number of icy spiculæ had begun to form; at some parts these spiculæ were so numerous that the mass looked like wet snow. In the river Almond, near Edinburgh, there were good specimens of the manner in which ice, collecting in one part of a river bed, forced the stream to flow in another portion of the bed hitherto unoccupied by the current, which extended the surface over which the water was exposed to a frosty atmosphere, and thus rendered a running current of water a place active in ice-making. In point of fact, it is, only on a more extended scale, the process I have already described as seen on the Pentland hills, where ice pillars two inches high were formed in quantities during a single night's frost.

The year 1854 was ushered in by a steady frost. On the three first days of January I examined various rivers. The ground at the time was thinly covered with snow, and the temperature of the air ranged between 15° and 30° of Fahrenheit. Severity was the prevailing character of the season; on the 2d the ice underneath the arches of the bridges over the Union Canal, near Edinburgh, was strong enough to walk over; on the 3d I crossed the river Eden on the ice, a little below the bridge at Carlisle, and I believe a period of many years has elapsed since this river was passable on foot so early in the winter. In succession I visited the following streams—Portobello rivulet, near where it enters the estuary of the Forth—temperature 32°; ground-ice in every part of the stream which favoured its lodgement; the ice wore a gray aspect from particles of sand and earth being lodged in it by the action of the current; in the stream near Liverpool this gray colour results after the ice has been for a few days under water.

Joppa rivulet, where it passes underneath the turnpike road, about a mile beyond Portobello, and immediately before it enters the estuary of the Forth—temperature 32°. The road is carried over this stream by a low stone arch, and the situation is one of the last where ice would be expected to be formed by atmospheric influence; the surface of the stream generally was covered with surface-ice; under the arch at the edges there were a few crystals, but the breadth of the surface of the stream was there clear of ice. In the bed, eight to ten inches under water, there was a plentiful crop of ice composed of small crystals interlaced with one another like snow, and of a pure beautiful hue; this lodgement extended over the whole of the bed under the archway where the nature of the ground and rapidity of the current favoured the accumulation, and for so small a stream shewed as fine a specimen of ground-ice, and the phenomena attending its formation, as could be desired. That it was brought down by the current from higher parts of the stream and lodged there could not be doubted, and it owed its preservation in such a locality to a current of ice-cold water continually playing upon it.

The Esk, at Musselburgh—temperature 32°. This stream must quite recently have reached the freezing temperature, for ground-ice was sparingly found in its bed, only in places where the current was rapid, and many of the plants in the bed in favourable enough situations had not yet received any ice. The river occupied a portion of its channel; in some localities ice gathering and blocking up a passage between two stones had diverted a part of the water into another part of the bed.

The Water of Leith, near a village of the same name, and at Saughton Hall, was examined—temperature in both instances 32°, with ground-ice under the arches of the bridges and other places favourable for its lodgement, but, like the Esk, the crop was not abundant.

A small rivulet which crosses the road that leads from Corstorphine village to the railway station—temperature 32·2°; As might be anticipated, the two-tenths of a degree was quite sufficient to prevent any ground-ice; the centre of the stream was free from ice, at the edges there were a few crystals much the same as I had seen under the arch at Joppa; no ice under water, otherwise the bed of the stream was most favourable for its reception. The temperature of this rivulet formed a contrast, being above 32°; while on the canal in its vicinity the ice under the arches of the bridges was walked over.

The river Almond, near Cramond—temperature 32°, ground-ice in plenty; one mass of it near a gorge where the water passed among some large stones I estimated to contain two cubic feet.

The river Eden, at Carlisle. On 3d January I left the city and crossed the bridge by the Glasgow and Carlisle road. On proceeding up the bank a few hundred yards, the stream at that part shewed a surface free from ice, and from ten to twelve feet deep, running with a steady powerful current—temperature 32°. In this part of the river there were lodgements of ground-ice by far the most extensive I have ever witnessed; one mass I estimated to contain a cubic yard; on some long slender stems of plants there were accumulations of spiculæ, in form like large turnip bulbs, collected in that shape by the turning and twisting of the stems in the current, colour opalescent, like snow immersed in water. A short distance further up the stream there were large quantities of ice, some of it eight feet below the surface, gathered together in a form which resembled a number of rough stone blocks resting against one another at an angle of inclination of 75°. The heads of the blocks leaning towards the current, *with the angle which first met the stream always acute*; this fact appeared to me to illustrate the process of the formation of these blocks, for it was there that the icy spiculæ brought down by the river were lodged. The collections of ice in the bed of the Eden on 3d January were more interesting and beautiful than any I had ever before seen, both for the quantity of ice and the depth at which it appeared below the surface. Like the collections on the stems of the plants, it had an opalescent hue, and there were many instances of pebbles* imbedded in it, varying in size from a walnut up to a stone of three inches diameter. The stream where the water ran uncovered by surface-ice contained a continued succession of groups of icy spiculæ floating down, affording an unerring indication that the bed of the river contained quantities of submerged ice. A field of these spiculæ had collected below Eden bridge, which the severity of the weather soon converted into a sheet of solid ice, leaving only the spiculæ, which had been raised out of the water by others underneath them, to attest its formation.

These details shew that a stream must soon be cooled down to 32° when its water has to bathe masses of ice in its downward progress; also that after it has attained this temperature it will lodge any free crystals of ice which may be borne along by the current in localities suitable for their reception, without reference to the external influence of atmospheric temperature to which that part of the stream may be exposed. Hence it is that under the arch of a bridge ground-ice is found as abundantly as in the most open part of the river.

In the Neva, at St Petersburg, I have been told that the anchor of a ship when drawn up will sometimes be found to have its fluke covered with ice, which it is easy to conceive may be the case after the long winter of Russia, when a short frost in Cumberland lodged a cubic yard of loose ice in the bed of the Eden.

On the Nature and Origin of different kinds of Dry Fogs. By M. C. Martins.

Ordinary fogs are composed of aqueous vapour in a vesicular state. Their appearance, the effect they have on our organs, and, in particular, the indications of hygrometrical instruments, and the optical phenomena they present, leave no doubt on this subject.

There are other kinds of fogs which are quite dry. Their

* Pebbles in rudely shaped icy barges have been described to me by parties who have often watched them as they floated along on the surface of a stream.

analogy to the former is confined to the circumstance of their filling the atmosphere, and disturbing, like them, the transparency of the air; but aqueous vapour has no part in their formation. Although noticed in meteorological registers, and mentioned by travellers, these fogs have not hitherto been the subject of a comparative study. Accordingly, their history is very little known; and it is probable that, under the name of dry fogs, meteorological phenomena of very different natures have been confounded. The object of the present notice is to distinguish four very distinct kinds of dry fogs, to point out their differential characters, and to call the attention of meteorologists to the consideration of them.

I. *Dry fogs produced by the smoke arising from the burning of peat.*

These fogs have been observed principally in Holland and western Germany. Munck, in the article Dry Fog (*Trockner Nebel*), in Gehler's Dictionary, and Kaemtz, under the title *Hoeherauch*, have given a satisfactory view of the ascertained facts. Before their time L. L. Fincke had devoted a particular work to this subject. I shall content myself by giving in this place a summary idea of the appearances of this kind of fog and its causes, in order that we may be in a condition to distinguish it from the others.

The dry fog of German meteorologists is not, properly speaking, a fog, but a smoke spread over a great extent of country. The report on this subject made at the meeting of German naturalists at Berlin, in 1828, by Professor Egen of Sœst, informs us how this fog is generated, elevated and diffused in the atmosphere. In the countries which form a belt about 11 myriametres broad, from Zuyder-Zee to the mouth of the Elbe, and over a surface of 430 square myriameters, there are 107 of these, or a fourth part, occupied with peat-bogs. The proportion is not in all places the same; in the region lying along the banks of the Ems, from Prussia to East Friesland, they form a third part of the surface of the country; in Eastern Friesland and the Duchy of Oldenburg, a fourth part; in the territory of Brême and Verden, only a sixth part. These bogs afford no other produce than peat, unless they are burned, or dried by means of drains or canals, which are very expensive. This last method requiring considerable capital, the poor inhabitants of these countries are obliged to prefer the former, which was introduced into Germany in the eighteenth century. The peat is burnt during seven or eight years; it is then left at rest for a period of from twenty to thirty years. Every year therefore a quarter of the entire surface may be burnt. In the present state of the population, it is about an eighth part, or thirteen square myriametres, that is burnt annually.

In order to sow buckwheat or oats, they turn up the soil in autumn that the clods of earth and the vegetables they contain may have time to dry during winter; they are set on fire in May, June, or July, according to the state of dryness of the superficial soil. The burning continues for a month, sometimes for fifteen days only. At certain spots it continues throughout the whole summer. The carbonization of this peat, which is still humid, begins in the morning after the disappearance of the dew, and continues till night. The cultivator takes care that the combustion does not proceed too rapidly; and there arises from it an extremely thick smoke which forms clouds, at first insulated, but on days when the fires are general, they unite towards the middle of the day and form so dense a fog that nothing can be distinguished at the distance of thirty metres. This smoke rises above the highest mountains of the country—that is to say, it exceeds a height of 650 metres. This immense cloud of 430 square myriametres and 600 metres in thickness, is driven by the east and north winds which prevail at this period, towards the countries situate to the south or west, where it darkens the air for whole days before becoming dissipated in the atmosphere. Fincke estimates the total weight of the carbonaceous particles thus raised into the atmosphere in the course of one summer, at 900 kilogrammes.

They are not satisfied with setting fire to the peat, but likewise burn the turf and noxious plants. This practice is followed in the neighbourhood of Siegen in Prussia, in Eifel on the banks of the Rhine, and in England. M. Egen gives proofs that the smoke arising from these burnings may extend very far.

In countries where these agricultural processes are unknown, an atmospheric origin is assigned to the dry fog. In order to obtain evidence of the truth, M. Egen has connected the directions of the wind with the indications of the dry fog for the years between 1821 and 1827, and in reference to the following cities:—Aurich, Emden, Grœttnigen, Meppen, Lingen, Bentheim, Stadtlohn, Minden, Munster, Salzuffeln, Detmold, Blomberg, Arnheim, Hamm, Paderborn, Lippstadt, Aix-la-Chapelle, Elberfeld, Coblence, Brest, Paris, Strasbourg, Texel, Halle, Altona, Bielefield, Clève, Solingen, Berleburg, Osnabruck, Sœst, Hildburghausen, Gotha, Carlshafen, Gœttingen, Treves, Brussels, Amsterdam, Essen, Cologne, Brunswick, Lunebourg, Reval, and Falmouth.

From these numerous observations, M. Egen draws the following conclusions :—

1. This dry fog is the smoke arising from the combustion of peat. It has a particular smell which is always recognised when it has once been felt.

2. Formerly less peat was burnt than at present, and the fog was less common. In the middle of the last century only two days of dry fog were reckoned on annually at Lingen-sur-Ems, but now they amount to eighteen.

3. The more remote we are from the peat district, the rarer they become. Thus at Lingen eighteen are observed every year; at Sœst, six or seven ; a day's journey further away, only four or five.

4. The intensity of the fog likewise diminishes the further we remove from the peat bogs. In Eastern Friesland, it is as opaque as the thickest moist fog ; at Sœst, situate 11 myriametres from the southern border of the peat region, we may always distinguish objects at the distance from 60 to 100 metres. It is seldom that the clouds cannot be seen, and the sun does not become invisible until it reaches the horizon ; at the distance of 35 myriametres from the peat deposits the smoke becomes only a light bluish vapour which spreads along the plains and valleys rather than on the mountains, because it rests on the ground.

5. The wind blows almost always from the peat-fields to the place where the fog is seen. At Emden, it comes by

the east and north-east; in Westphalia, by the north-west, north, or north-east; at Gœttingen, where it has been studied by MM. Gauss and Haussmann, by the north and north-west; at Jever, by the south. There are no doubt exceptions; they are caused by shifting winds, which do not allow us to ascertain the original direction of the current which brought the smoke.

6. The most evident proof of the origin of the *Landrauch* is that, in most cases, we can prove the coincidence of great combustions with the appearance of the dry fog. Thus, on the 18th and 19th of June 1821, about mid-day, the peat-bog was enveloped in a thick cloud of smoke; about five hours after, the countries between the North Sea and Siegen, and between Cleves and Minden, were likewise covered with smoke. On the 22d May 1822, in the morning, the peat was concealed by the smoke; about six o'clock, all the country between the North Sea and Coblentz, and between Arnheim and Minden, was occupied by it. This is a surface of 1035 square myriametres. In reference to that day M. Egen received notice from forty-two localities comprised in that space.

The same observer has further satisfied himself by hygrometrical experiments, in which he made use of Daniell's hygrometer, that the humidity of the air was not greater during the dry fog than on the days which preceded and followed its appearance. August at Berlin, and Kaemtz at Halle, made the same experiments and obtained the same results on the dry fog of 1834.

These facts appear to us sufficient to establish the origin of certain dry fogs. One point alone remains to be determined, namely, whether this smoke can be transported to great distances without being dissipated, and give rise to the appearance of the dry fogs which have been noticed principally in Holland, Western Germany, and the north of France. Many authors have decided this point in the affirmative. Fincke has traced it for the space of 22 myriametres without its intensity being diminished. The greater part of German meteorologists, such as Egen and Kaemtz, believe that the smoke arising from the combustion of peat in Westphalia may obscure the atmosphere at Bâle, Paris, Brest in the south, and Copenhagen in the north. Yet, notwithstanding the extent, thickness, and density which must be conceded to these clouds of smoke, we cannot admit that they could cover a portion of Europe like certain general dry fogs, such as those of 1764 and 1783, whose history has been preserved to us by writers of the last century. These fogs form a second class which I shall endeavour to characterize.

II. *General dry fogs produced by volcanic eruptions. Trochner Nebel* (Germ.); *Dry Fog* (Eng.); *Sonnenrauch*, Kastner.

To give an idea of this kind of fog, I think I cannot do better than describe the most celebrated of all, that of 1783. This task is the more easy, since the favour meteorology then enjoyed has raised a crowd of observes who have transmitted the most valuable documents respecting this curious phenomenon in the *Ephemerides de la Société Meteorologique de Manheim*.

I shall first trace the progress of this fog, that is to say, determine the period of its appearance and disappearance at the places where it has been observed; I shall then treat of its nature, and the phenomena which accompanied it.

Dry fog of 1783.—Speaking in a general way, this fog extended from Norway to Syria, that is to say, over a space of 25 degrees of latitude; and from England to Altai, that is, over 120 degrees of longitude. It was observed, more or less, during the whole period of time between the 24th May, the day of its first appearance at Copenhagen, and the 8th October, when Lamanon saw it for the last time in the valley of Servieres in Dauphiny.

Height of it.—When on Mount Ventoux, 1910 metres above the sea, Lamanon still saw much of it above him. He satisfied himself, by going from the sea-shore to the highest mountains, that the lowest part was thickest and dryest. Among the French Alps, the shepherds assured him that it covered the highest peaks, which implied a thickness of 4000 metres. At Geneva, Senebier ascertained that it exceeded the height of the great Salève, which is 1484 metres above the sea. De Saussure himself observed this fog at the hospice of Grimsel (1880 metres above the sea), on the 10th, 11th, and 12th July. It was little observable on the two last days, but, according to the account of the people at the hospice, it was as dense in the end of June on the Grimsel as in the plain.

At Narbonne, on the contrary, it never rose, according to Marcorelle, above 780 metres; at a greater elevation the sky remained always clear. From Neufchatel the peaks of the Alps were seen above the fog. But Saussure, who was in the neighbourhood of Rolle on the 3d July, could not distinguish, between five o'clock in the morning and noon, the peaks of the Jura, about three leagues distant. At Padua, and even at Rome, the fog appeared suspended in the air and not to touch the horizon.

From what has been said it may be concluded that the fog was variable in thickness; it was so even according to the hour of the day, for Lamanon being, on the 21st of June, on the top of Ventoux before the rising of the sun, remarked that the fog ascended as that luminary rose above the horizon.

Physical properties of this Fog—Its appearance.—With the exception of Maret of Dijon, all observers were struck with the extraordinary appearance of this fog. "It was," says Senebier, "a bluish vapour, sometimes reddish, never gray like ordinary fogs; it coloured objects blue. During the days on which it was dense, houses and trees disappeared at the distance of a third of a league." Toaldo at Padua, Marcorelle at Narbonne, Cotte at Laon, Præus at Sagan, Father Onuphre on St Gothard, and Saussure on the Grimsel, compare it to a smoke, and even a dust totally different from ordinary fogs. These testimonies are corroborated by the examination of the other properties of this vapour.

Its hygrometrical state.—The very title of this memoir imposes upon me the obligation of shewing that the fog of 1783 was completely dry, and had no effect on hygrometrical instruments, nor on hygrometrical bodies. In order to prove this, I have only to refer to the statements of the natural philosophers who observed it. At Geneva, Senebier found that it did not act on the hygrometer as a humid fog. Van Swinden is not less explicit. At Franecker, in Holland, the air was in no degree moist, and the hygrometers indicated the maximum of dryness on the 23d June, a day on which the fog was very dense. During the whole of this month the weather was very dry.

At Manheim, observers satisfied themselves that this fog was not moist but dry, judging by the hygrometer, the evaporation of fluids, the drying of moistened bodies, such as hay and the dust of roads, and its continuance during rain. At Padua, Toaldo finds it completely different from ordinary fog, and notifies that the hygrometers indicated *dry*. At Salon, in Provence, Lamanon observed that salts did not deliquesce, and it did not cause the hygrometer to ascend. In 1783, the salt pits of Hyères crystallized fifteen days sooner than usual.

At Narbonne, however, after having been dry, this fog became humid, owing to winds from the east, which prevailed on the 26th, 27th, and 28th of June. "At Laon," says Cotte, "it began on the 18th June; it was very low and as thick as in December, accompanied by a very cold south wind. On the 19th there was a considerable storm; the fog appeared afterwards to increase, and continued to be cold while the south wind blew, that is, to the 24th. During this time, the fog was very humid, as my hygrometers indicated to me. On the 24th the wind changed to north, the air became warm, and the fog altered its character; it became dry, and might be compared to a smoke rather than a fog. The heat and dryness always increased, north and north-east winds continuing to prevail.

A single observer, Maret, affirms that at Dijon this fog appeared to him in every respect like ordinary fogs. He perceived, however, that vegetables were dried during the day.

This evidence does not appear to me to invalidate that of all the others, particularly when such observers as Van Swinden, Toaldo, Senebier, and Lamanon, ascertained the dryness of the fog experimentally.

Density of the fog in 1783.—At Copenhagen, the sun was clearly visible as long as it had not risen from 20 to 30 degrees above the horizon. At Laon, during the day, the light of the sun was of a pale orange colour; at its setting, it appeared of a fiery red. The moon presented the same appearance. Such is the statement of Cotte.

Smell of the dry fog of 1783.—The action of this fog on some of our organs was very different from what is observed in aqueous fogs. At Franecker, in Holland, Van Swinden felt a sulphurous odour which excited cough and penetrated into the closest places; it was particularly sensible on the 24th June. At Grœningen not only a sulphurous smell but even a sulphurous taste was perceptible. Marcorelle found it to possess the sharp and stimulating odour of smoke. At Salon it weakened the eyes; individuals whose chests were delicate experienced disagreeable sensations. Cotte and Toaldo mention nothing of this sort; but the former, on the testimony of others, relates that in Provence and elsewhere it had a sulphurous, fetid odour, which tickled the eyes. However this may be, the peculiarity in question was not observed in all places. Senebier, Maret, and Cotte state that the fog was without smell, and a great number of observers make no mention of its action on the organs of sight, taste, or smell.

Meteorological phenomena accompanying the dry fog of 1783.—What has been said will, I think, be sufficient to shew that the fog of 1783 was altogether of a special nature, and in no respect formed by aqueous vapour. This opinion will be confirmed by the study of the concomitant phenomena.

Its appearance did not take place in analogous circumstances, but in very varied states of the atmosphere. At Copenhagen it appeared suddenly after a series of clear and warm days; south-east-south and south-south-west winds succeeded each other in the atmosphere. At Franecker in Holland, Sagan in Silesia, and Peissenberg in Bavaria, the south-west wind prevailed when it was observed for the first time. At Manheim the winds were variable before it first appeared. On the same day it blew successively from west-south-west, south-west, and north-west. At Rochelle the south-west prevailed for two days when it appeared, and the same day the wind shifted in the evening to west-north-west. At St Gothard the west-north-west wind blew from the evening before the fog arrived.

At Dijon the south-west had continued for three days, and turned to the south at the moment of its first appearance. On its second appearance, 22d June, the wind was from west-north-west, north-west, or north. At Laon the fog arrived accompanied by a very cold wind from the south. At Padua it was preceded by numerous storms; on the 17th the wind blew from the north; on the 18th from the west-north-west in the morning, south-west at mid-day, and south-east in the evening. At Narbonne the weather was calm and the heat great for two days. At Rome it likewise came with a south-west wind.

We thus perceive that the fog appeared neither with the same wind, nor in the same meteorological circumstances; in general, however, it appears to have been brought by a south-west wind. When it had once overspread a country, nothing could make it disappear, neither wind, rain, nor storm. The following are some examples of this. At Manheim there were 23 days of rain, and twelve storms during its continuance. On three days it thundered, while the fog was of extreme density; on the 27th June its density was such that one could not see a quarter of a league, and yet there was so severe a storm, that the thunder broke in thirteen localities in the neighbourhood. At Geneva, Senebier made the same observations; neither rain nor wind had the power of dissipating it. On the 12th July, among others, there was a frightful thunder-storm which struck eight houses in the town. At Padua fourteen storms of lightning occurred during the continuance of the fog. A tempest came on in the morning of the 26th, accompanied with claps of thunder which were heard from one sea to the other, and struck five or six houses in the town of Vicence alone: the fog was not dispersed. At Narbonne, the north wind blowing violently, it almost wholly disappeared from the 4th to the 6th of July; but on the return of calm weather, it again enveloped, not as formerly the whole celestial hemisphere, but a zone comprised between 0 and 20 degrees above the horizon. To the testimony of Hemmer, Senebier, Toaldo, and Marcorelle, I may add that of Van Swinden, who was astonished to see it continue in spite of rains, winds, and storms.

Origin of the dry fog of 1783.—Every meteorologist who has taken the trouble to read the preceding details, will be persuaded, like myself, that the fog of 1783 was not composed of aqueous vapour. The hygrometrical experiments of Senebier, Van Swinden, and Lamanon,—its continuance for two months of the summer, in all kinds of weather, and during all kinds of winds,—sufficiently prove this.

This fog was smoke—Toaldo, Marcorelle, Cotte, and De Saussure are all agreed on this point; the latter supports his opinion by that of the Bernese mountaineers who, he says, are so well experienced in fogs.

Its origin appears to us to be that already assigned to it by some observers of the period, namely, the earthquakes and volcanic eruptions which in the same year shook Iceland and Calabria. We know as a fact that in these eruptions the volcanoes threw up into the air masses of ashes, which formed true clouds, which the winds carried to a distance. In the neighbourhood of the volcano, the light of the sun was completely obscured by them, as in the eruption of Vesuvius, in the year 70, when, according to Pliny the younger, the obscurity was like that of a shut-up apartment. On the 22d and 23d October 1822, lanterns were used in the villages near Vesuvius. M. de Humboldt, who bears testimony to these facts, compares them to what so often takes place at Quito during the eruptions of Pichincha. During the eruption of Catopaxi, 4th April 1768, the shower of ashes at Hambato and Tacunga was such that the inhabitants likewise went about in open day with lanterns. These phenomena were also observed at great distances from the ignivomous crater. During the eruption, in the month of December 1760, the smoke of Vesuvius, carried by the wind, darkened the sun for an entire day at Cuccaro and Cilento, towns in the principality of Salerno, situate 92 kilometres from the mountain. On the following day the grass was covered with ashes.

Ashes are conveyed by the winds to considerable distances. After the violent detonations, like the discharge of artillery, which alarmed the inhabitants of Barbadoes on the 30th April 1812, there was seen the following day, 1st May, above the horizon of the sea, a black cloud which already covered the rest of the sky, and which soon after spread itself in the part where the light of the twilight began to appear. The darkness then became so great that in rooms it was impossible to discern the place of the windows, and in the open air many could not discern either the trees or outlines of the neighbouring houses, nor even white handkerchiefs placed five inches from the eyes. This phenomenon was caused by the fall of a great quantity of volcanic dust arising from the eruption of a volcano in the island of St Vincent. This new kind of rain, and the darkness resulting from it, did not terminate till between twelve and one o'clock. The island of St Vincent is 170 kilometres west from Barbadoes. During the eruption of Hecla, in 1766, the clouds of smoke produced such a darkness, that at Glaumba, 50 leagues distant, people could not walk but by groping their way. In 1794 the whole of Calabria was enveloped in thick clouds vomited from Etna.

If examples are desired of transportation to great distances, the following may be given as proofs. Procopius assures us that in 472, the ashes of Vesuvius were carried as far as Constantinople, that is 250 leagues. In the formidable eruption of Tomboro, a volcano in the island of Sumbava, which took place in 1815, the ashes extended to Java, Macassar, and Batavia; they even reached Bencoolen, and Sumatra, which is as remote from the point of departure as Etna is distant from Hamburg, namely, 16 degrees of latitude, or more than 1500 kilometres.

If we compare these results, arising from an insulated eruption, with those which must be produced by multiplied and continuous eruptions at the two extremities of Europe, in Calabria on the one hand, and in Iceland on the other, we will not hesitate to ascribe to them, along with Toaldo and Van Swinden, the origin of the dry fog of 1783.

In Calabria and Sicily, says Toaldo, the earthquakes began in February and continued till the end of March. The outline surface of Calabria was completely changed; upwards of a hundred mountains were torn up, turned over, and transported; an equal number of deep pits were opened and remained unfilled. Fifty lakes were produced by the stoppage of rivers, and the number of victims to this calamity exceeded a hundred thousand men.

In Iceland the same disasters happened. Before the flame broke out, the atmosphere of the island was so filled with smoke, vapour, and dust, that the ground appeared red. Near the mountains it was night at mid-day. The earthquakes and eruptions began on the 1st June 1783. The smoke and vapours issuing from the earth formed three columns visible for 55 kilometres. On the 8th June the darkness was complete. On the 11th the river Skapta disappeared, dried up in twenty-four hours. Its source was in the mountain called Klofajokull; previously it was lost in a gulf named Skaptargliufur, and ran in a canal eight kilometres in length by sixty metres in depth, between very high rocks. This canal was filled by a stream of lava, which by degrees overran the banks and covered all the country, except the high mountains. Its breadth, from the centre, was twelve kilometres towards the east, and much greater towards the west. Arrested by mountains on the south, it ended by surmounting this obstacle, and spread itself over the plain. This sea of fire boiled in a fearful manner, carrying everything along with it. In the plain its depth was still from thirty to forty metres. Throughout the whole track of the incandescent lava the herbage was burned, the rivers dried up, villages destroyed, men and animals suffocated. After these details we may form some idea of the torrents of smoke which must have risen into the air, along with the vapours and gases escaping from the bowels of the earth.

At the beginning of October the ground of Iceland was still agitated; flames and smoke issued from the ground in the centre of the island. At length, in November, these terrible phenomena ceased, but a volcanic island which had been thrown up sixteen miles from the coast of Iceland, still emitted flames in February 1784.

If we compare these facts with the dates of the appearance of the dry fog, we will observe a very remarkable agreement. The first appearance was at Copenhagen, on the 24th May, precisely at the time when the ground of Iceland began to emit smoke, gases, and vapours, phenomena which were precursors of the eruptions and earthquakes about to succeed. It was likewise at Copenhagen that the fog continued longest. From Copenhagen it extended to France, Germany, and Italy, where it was remarked almost everywhere from the 16th to 18th June. At the end of the month it was observed in the south, in Portugal and Syria; in the east, at Moscow and Buda in Hungary. This general progress from north to south, and from east to west, leads us to seek for the origin of this fog in the north-west of Europe, precisely where we find Iceland, the permanent theatre, throughout the whole summer of 1783, of a true *burning of the earth,* as it was called by cotemporary authors.

The dry fog, or rather smoke, which covered Europe during the summer of 1783, was therefore owing to volcanic eruptions and combustions which took place in Iceland, and perhaps to the earthquakes which laid waste Calabria. The rarity of the phenomenon is explained by the rare occurrence of eruptions so continuous and important as those which ravaged these two countries. For sixty-seven years meteorologists have not observed a fog so general and permanent in Europe, and for the same period no eruptions have happened comparable to those of 1783. But this example proves to us that dry fogs, of a local character, observed at great distances from any active volcano, may be connected with eruptions, and the combustion of the vegetables which cover the soil enveloped in burning lava. In this point of view, the fogs formed by the ashes and smoke of volcanoes enter into the category of those which are owing to the combustion of peat-grounds in Westphalia. Both originate in extensive conflagrations; both are produced, not by water, but by fire; and both are completely different from the fogs formed by aqueous vapour.

III. *Dry fogs at the horizon, of unknown origin.*

Horizon enfumé, Fumée d'horizon; *Hâle* of the Swiss; *Hæherauch* of the Germans; *Callina* of the Spanish.

The dry fogs of which we have hitherto spoken are owing, the one to the combustion of peat, the other to volcanic eruptions; it is different with the smoke of the horizon. Scarcely noticed by meteorologists, it has not hitherto been the subject of proper examination. The notes found here and there are insufficient to furnish a complete description, much less to establish any theory. In endeavouring to trace the principal appearances of this phenomenon, I shall not attempt to disguise either the difficulties or imperfections of this part of my undertaking. If I draw the attention of observers to it my object will be gained.

The horizon-smoke appears to be more common and more intense in the south than in the north of Europe, in warm regions than in cold ones. Thus, in Spain, according to Willkomm, it continues during the months of June, July, and August, when the weather is fine. M. de Humboldt speaks of it as a habitual appearance at Acapulco, on the western side of Mexico, but not at Cumana, where this vapour, however, interfered with his astronomical observations from the 10th October to 3d November. In the north it is not seen often; we have not observed it in Lapland. In Switzerland it appears more common, and strikes the attention of every one, because it conceals the view of the chain of the Alps during the fine weather which attends the north and northeast winds. In every instance it appears in connection with a clear sky, and, in general, north winds.

Its appearance is that of a gray or reddish smoke surrounding the horizon, and rising at the maximum to 20 or 25 degrees above it. Commonly its thickness is only from 5 to 10 degrees. The upper edge is not distinctly defined on the sky; the latter has not the deep azure colour observed before rain, and is of a bluish white. The air is not perfectly transparent, objects are indistinct and do not appear near the spectator as in days when the air is saturated with moisture. Travellers who then ascend mountains, induced by the long track of fine weather, often experience a disappointment which they would have avoided if they had chosen a fine day preceded or followed by days of rain. When the sun penetrates into this smoke, he assumes a reddish tint, his splendour is much weakened, and the disk appears surrounded with concentric circles having a vibratory motion.

Hygrometrical instruments remain unaltered on the appearance of this fog; or, to speak more correctly, they move to the point of dryness, as experiments by myself and others prove.

M. Willkomm is the only observer who reached this fog and penetrated into it; but he represents it as a vapour resembling a mirage, which continually flees before the traveller. Thus, when he arrived at the villages or mountains, the view of which was concealed by the horizon-smoke, even when he was in the midst of it, he was unconscious of its presence. Nothing informed him that he was surrounded with an air which, seen at a distance, appeared as opaque as a thick smoke could have done.

With circumstances so extraordinary before us, we do not hazard any hypothesis; and confine ourselves to making a new appeal to the zeal of meteorologists, astronomers, and travellers.

*The Callina or horizon-smoke in Spain.**

The fog to which Spaniards give the name of *Callina* has no connection with those which we name dry fogs (*Landrauch*). The latter are caused by the combustion of peat in the north; at least that has been demonstrated in the most evident manner in regard to many of them. I shall not enter on the question whether the dry fogs of Germany are smoke arising from the combustion of heath or peat in Eastern Friesland, the Duchy of Oldenburg, the provinces near the Baltic, Russia, Scandinavia, or Iceland. The callina of the south of Spain has not the same origin; in fact the dry fog of Germany is a local phenomenon, appearing suddenly, continuing a few days and then disappearing. It has the

* By Maurice Willkomm.

smell of burning, or at least a peculiar smell, and envelopes the objects near it in a bluish vapour. The callina is completely different; it is a permanent fog which every year, during the whole summer, covers the horizon and impairs the transparency of the sky. I have observed it for two years, always in the same circumstances.

The callina appears in the middle or at the end of June. It forms around the horizon a band of fog of a bluish-gray colour, which increases with the temperature. In the middle of August, when the temperature reaches its maximum, it covers about a quarter of the celestial vault. At this time the colour of the fog at the horizon is of a reddish brown. Higher up it passes into yellow, and from its edges rises a transparent vapour like a light gauze, which covers the whole sky and imparts to it a leaden hue. When the callina reaches this degree of intensity, it embraces the whole horizon, and disturbs the view of objects to a distance of three or four leagues. All those objects which are nearer are, on the contrary, perfectly distinct. I have never felt the least odour, and we do not observe when we enter into the fog. The nearer we approach to an object veiled by the callina, the more distinct its outlines become, and at the distance of some leagues it is perfectly distinct and in full light; no trace of the fog is seen around one.

From the end of August the callina diminishes with the heat, and disappears in the end of September or in the beginning of October, at the time when the equinoctial gales prevail. Sometimes it diminishes when the approach of a storm refreshes the atmosphere, which is in general very rare in summer. But on the following day after the storm, the thickness of the callina is much less, the sky purer and of a deeper blue. At the end of a few days it recovers its former dimensions. I have observed the callina in the warm plains of the Guadalquiver, of La Mancha, in the Asturias, and the province of Almeria, more rarely among the mountains. Its increase and diminution with the temperature seems to indicate a connection with it. This is likewise the opinion of the people of Spain.

Dry fogs properly so called.—It now remains for us to mention certain fogs which are neither smokes produced by combustions, nor callina, but vapours, among which the observer finds himself, without experiencing the slightest sensation of humidity, and hygrometrical instruments not indicating the slightest trace of it. On this subject documents are still rarer and more imperfect than in regard to the other three species of fogs. Having never observed fogs of this nature, which have been described by two great meteorologists, De Saussure and Humboldt, I think I cannot do better than allow them to speak for themselves.

"After many days of decidedly fine weather," says De Saussure, "when the air is not perfectly transparent, we perceive a bluish vapour floating in it which is not of an aqueous nature, since it does not affect the hygrometer; but its nature is not yet known to us."

It may be asked, in the first place, if this bluish vapour is not the halo which accompanies the callina? But how are we to suppose that such an observer as Saussure should have remarked the halo, and not attended to the horizon-smoke which accompanied it? It must be rare in Switzerland, for it is never referred to in his *Voyages dans les Alpes;* and in our ascents and prolonged stations among the mountains we never saw it but once.

The following notice from M. de Humboldt is a much better characterized example of a true dry fog. On the summit of Silla, a mountain which rises near the town of Caraccas, to a height of 2630 metres above the sea, MM. de Humboldt and Bonpland were much struck with the apparent dryness of the air, which seemed to increase as the fog formed. "When I took the hygrometer from its case," says the illustrious traveller, "to subject it to experiment, it marked 52 degrees (87 deg. Sauss.) The sky was clear, yet tracks of vapour with distinct contours passed from time to time amongst us, grazing the earth. Deluc's hygrometer went back to 49 degrees (85 deg. Sauss.). Half an hour later, a large cloud enveloped us; we could no longer distinguish the objects nearest us, and we saw with surprise that the instrument continued to advance to dry, that is to 47°·7 (84 deg. Sauss.). The temperature of the air was, during the time, from 12 to 13 degrees. Although in the whalebone hygrometer the point of saturation in the air is not at 100 degrees, but at 84°·5 (99 deg. Sauss.), this effect of a cloud on the movement of the instrument appeared to me most extraordinary. The fog continued sufficiently long to admit of the fillet of whalebone, by its attraction for the molecules of water, to elongate itself. Our clothes were not dampened. A traveller, experienced in observations of this kind, recently assured me that he saw on the naked mountain of Martinique, a similar effect of clouds on the hair hygrometer. It is the duty of a natural philosopher to relate the phenomena which nature presents, especially when he has neglected nothing to avoid errors of observation."

M. Rozet, an officer of the état-major, has often observed, during his investigations among the Pyrenees, a bed of horizontal vapour at a height varying from 230 to 1150 metres above the sea. But in order to determine whether these vapours belong to the class of dry or humid fogs, it is necessary that the observer should have been accustomed to hygrometrical experiments.

In conclusion, it appears to me that the existence of true dry fogs, as dense as ordinary humid fogs, has not been perfectly demonstrated. Saussure's bluish vapour is nothing more than a disturbance of the transparency of the air, and not a true fog. The insulated observation of M. de Humboldt has been made with a defective instrument, and very slow in its indications,—the whalebone hygrometer of Deluc. On this subject, therefore, meteorology requires new researches, undertaken with the new means of investigation for which she is indebted to the progress of experimental physics. It is unquestionable that the degree of humidity in fogs is variable; but it is not yet demonstrated that fogs exist so dense as to veil objects at the distance of a kilometre, for example, and so dry as in no degree to affect delicate psychrometrical instruments; at all events, that these fogs are not the smoke arising from great combustions. This is a subject of study as new as it is interesting. But to enter upon it with the well-founded hope of resolving the question, we beg of observers to employ M. Regnault's aspirator along with hygrometrical instruments. This instrument enables us to weigh the quantity of aqueous vapour contained in a given volume of air, and it thence follows that the results are free from all the causes of error which may attach to Saussure's hygrometer, August's psychrometer, that of Daniell, and even M. Regnault's condenser. In a thick fog the eye can scarcely notice the exact moment when the vapour is deposited in small drops on the silver capsule of the condenser, or of Daniell's hygrometer, and consequently there is always uncertainty as to the degree of the thermometer at which the dew is deposited. Travelling meteorologists will be much to blame if they neglect the hygrometrical study of fogs, carried on by means of these portable instruments. An approximating result is always preferable to absolute ignorance. Our numerical data and physical experiments are exact, compared with those of our predecessors. But our successors, provided with more delicate apparatus, and more extensive knowledge, will find precisely the same faults with us that we sometimes allege against those who have gone before us in the same path. Absolute truth is a phantom which man continually approaches, with the certainty of never reaching it.

Synopsis of Meteorological Observations made at the Observatory, Whitehaven, Cumberland, in the year 1853. By JOHN FLETCHER MILLER, Esq., Ph.D., F.R.S., F.R.A.S., Assoc. Inst. C.E., &c. Communicated by the Author.

1853.	STANDARD BAROMETER, CORRECTED AND REDUCED TO 32°.						SELF-REGISTERING THERMOMETER.						PLUVIOMETERS.			Wet Days.	Evaporation Gauge.	PREVAILING WINDS.	
	Max.	Min.	Mean Atmospheric Pressure at 3 P.M.	Pressure of Vapour.	Mean Pressure of Dry Air.	Range.	Absolute. Max.	Absolute. Min.	Mean of Max.	Mean of Min.	Approximate Mean Temperature.	Range.	High Street, 90 feet above Sea. Rain, &c.	High Street, 90 feet above Sea. Snow.	St James' Church Steeple, 78 feet above the Street.			Deduced from two Daily Observations.	Mean Force of Wind, 0—6.
	Inches	Inches	Inches	Inches	Inches	Inches	°	°	°	°	°	°	Inches	Inches	Inches		Inches		
Jan.	30·190	28·900	29·467	0·251	29·216	1·290	51·	27·5	44·30	37·91	41·10	23·5	5·886	...	3·362	20	1·197	SW.	3·2
Feb.	30·104	28·886	29·634	·199	29·435	1·218	43·	20·	38·09	30·50	34·29	23·	2·244	0·250	1·553	17	1·083	NE.	2·2
March	30·156	29·470	29·822	·223	29·599	0·686	53·5	22·5	44·55	34·10	39·32	31·	1·204	·107	·888	14	1·749	Easterly	1·6
April	30·198	28·898	29·708	·293	29·415	1·300	57·	33·5	51·20	40·93	46·06	23·5	2·478	...	1·850	17	2·239	Westerly	2·2
May	30·220	29·558	29·846	·326	29·520	0·662	75·	35·	61·03	44·04	52·53	40·	0·272	...	0·080	5	4·999	NE.	2·0
June	30·178	29·399	29·730	·437	29·293	0·779	75·5	44·	64·33	50·96	57·64	31·5	3·145	...	2·616	16	3·845	SW.	1·9
July	30·120	28·820	29·697	·473	29·224	1·300	70·	50·5	63·82	54·01	58·91	19·5	4·927	...	3·330	21	2·696	SW.	2·3
Aug.	30·368	28·996	29·786	·436	29·350	1·372	70·5	46·5	64·10	53·74	58·92	24·	3·119	...	2·392	13	3·126	Westerly	1·9
Sept.	30·460	28·718	29·837	·386	29·451	1·742	68·	42·	60·82	50·51	55·66	26·	2·733	...	1·818	15	2·628	SW.	2·4
Oct.	30·050	29·086	29 533	·361	29·172	0·964	59·5	37·5	55·69	47·73	51·71	22·	6·591	...	4·058	24	1·607	SW.	2·3
Nov.	30·434	29·616	29·907	·282	29·625	0·818	56·5	31·	47·70	41·65	44·67	25·5	4·301	...	2·953	17	1·240	SW.	2·2
Dec.	30·436	29·340	29·885	·218	29·667	1·096	52·	23·	39·72	33·37	36·54	29·	0·504	·149	·284	13	0·925	Easterly	1·7
1853.	30·243	29·140	29·738	·324	29·414	1·102	60·9	34·4	52·94	43·28	48·11	55·5	37·404	0·506	25·184	192	27·334	SW.	2·1
1852.	30·304	29·068	29.698	·343	29·355	1·236	64·2	35·8	55·10	45·20	50·15	57·5	50·030	·007	35·957	190	30·348	SW.	2·3
1851.	30·381	29·171	29·809	·321	29·494	1·210	62·3	35·1	53·86	44·39	49·12	55·0	43·120	·744	32·110	195	25·340	SW.	2·2
1850.	30·372	29·074	29·788	·319	29·473	1·298	63·1	33·5	54·13	44·07	49·40	62·5	40·473	·352	28·636	189	27·349	SW.	2·1
1849.*	30·346	29·055	29·778	·321	29·473	1·291	62·3	33·7	53·24	44·15	48·69	56·8	38·999	·090	28·210	190	28·699	SW.	2·1

* Max. and Min. uncorrected for temperature, except for 1849.

TABLE II.—*Hygrometer.*

1853.	3 P.M.				Weight of Vapour in a Cubic Foot of Air.	Required for saturation of a Cubic Foot of Air.	Degree of Humidity, (complete Saturation 1·000).
	Dry Bulb.	Wet Bulb.	Deduced Dew Point.	Complement of Dew Point.			
	°	°	°	°	Grains.	Grains.	
January	43·15	41·05	38·48	4·67	2·91	0·51	0·853
February	37·22	35·09	31·95	5·27	2·35	0·47	·832
March .	43·66	39·78	35·12	8·34	2·60	0·89	·745
April .	49·43	46·31	43·05	6·38	3·38	0·80	·806
May .	59·46	51·60	46·07	13·39	3·67	2·11	·635
June .	63·41	58·18	54·56	8·85	4·86	1·67	·745
July .	63·55	59·75	57·04	6·51	5·28	1·27	·807
August.	63·14	57·79	54·43	8·71	4·79	1·68	·741
September	59·58	54·52	50·93	8·65	4·34	1·46	·749
October	54·64	51·54	49·00	5·64	4·09	0·84	·832
November	46·98	44·55	41·75	5·23	3·24	0·64	·835
December	38·47	36·88	34·50	3·97	2·57	0·37	·873
1853.	51·89	48·08	44·74	7·15	3·67	1·06	0·788
1852.	53·99	49·89	46·48	7·51	3·88	1·16	·782
1851.	52·36	48·77	45·74	6·62	3·07*	1·76*	
1850.	52·35	48·46	45·17	7·18	...	...	
1849.	52·00	48·21	44·91	7·09	3·61	1·10	
1848.	51·93	48·23	44·98	6·95	...	...	
1847.	51·94		44·12	7·82	...	...	

* Calculated from observations taken at 9 A.M. and at 3 P.M.

TABLE IV.—*Seathwaite. Wet Days.*

Month.	1845.	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.
Jan. .	22	25	13	14	20	12	27	28	21
Feb. .	11	15	10	25	17	23	15	17	13
March	15	23	14	24	13	12	22	6	18
April	11	21	16	16	19	21	17	3	21
May .	15	14	23	11	15	19	21	16	11
June .	18	11	15	19	10	16	20	25	16
July .	15	25	13	19	18	15	18	18	25
August	22	16	17	25	18	24	19	22	15
Sept. .	15	12	23	16	10	12	9	16	20
October	21	24	19	22	18	24	25	17	25
Nov . .	20	17	21	22	20	24	15	23	18
Dec. .	26	16	18	19	15	21	11	30	14
Seathwaite,	211	219	202	232	193	223	219	221	217
Whitehaven,	193	200	191	211	190	189	195	190	192
Greenwich,	187	161	175	206	103	141	146	152	184

Table III.—*Monthly Fall of Rain at Seathwaite, Borrowdale, Cumberland, in the Years* 1845–1853 *inclusive.*

Month.	1845.	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.
	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches
January, .	16·81	17·07	6·29	9·67	24·96	7·34	28·63	27·65	23·12
February, .	3·48	11·51	8·27	30·55	7·55	22·58	15·33	20·05	3·84
March, . .	13·21	17·85	2·53	11·36	5·51	4·13	9·36	·98	4·59
April, . .	10·57	7·70	6·81	4·19	3·88	15·62	6·08	·74	12·67
May, . . .	4·57	4·40	8·08	3·05	6·52	7·14	4·53	11·59	·89
June, . . .	8·25	6·41	7·27	11·30	3·97	6·83	11·63	12·33	4·07
July, . . .	8·65	20·80	3·32	17·76	16·64	11·20	14·47	7·65	19·67
August, . .	15·61	10·58	10·48	13·91	9·92	16·22	13·16	12·37	10·47
September, .	9·77	4·60	13·28	7·00	4·08	5·85	4·30	4·64	10·42
October, . .	15·17	25·43	20·52	17·32	16·14	12·94	20·38	8·44	13·25
November, .	20·84	10·46	21·85	14·07	18·75	22·60	3·74	17·47	9·47
December, .	24·94	6·70	20·54	20·71	7·55	11·51	7·99	32·83	1·23
At 10 inches above ground,	151·87	143·51	129·24	160·89	125·47	143·96	139·60	156·74	113·69
At 22 inches,	...	...	126·80	157·22	121·57	...	135·86	150·88	111·61
Whitehaven,	49·20	49·13	42·92	47·34	39·00	40·47	43·12	50·03	37·40
Greenwich, .	22·30	25·30	17·80	30·20	23·90	19·70	21·60	34·40	29·00

There are four rain-gauges stationed at and in the neighbourhood of Seathwaite,—one at 10 inches, and the other at 22 inches, above the surface; the former is planted in a small garden, and the latter in a more exposed situation, in an adjacent field. A third gauge is fixed on the "Stye" or shoulder of "Sprinkling Fell," about a mile and a half distant from Seathwaite, in a south-westerly direction, and 580 feet above it, or 948 feet above the sea-level. Fall on "Sprinkling Fell," in 1850, 189·49 in.; 1851, 169·62 in.; 1852, 167·73 in.; and in 1853, 124·91 inches.

The fourth gauge is near the top of Seatollar Common, 1338 feet above the sea, or 970 feet above the hamlet, and about the same distance from it as the Stye, bearing nearly due north. Depth of rain on Seatollar Common in 1850, 138·84 inches; in 1851, 141·42 inches; in 1852, 156·59 inches; and in 1853, 111·45 inches.

TABLE V.—*Maximum Fall of Rain in 24 hours at Seathwaite, in each Month of the Years* 1845–1853 *inclusive.*

Month.	1845.	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.
	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches
January, .	3·05	2·50	1·44	1·82	†3·32	2·60	4·24	4·40	3·84
February,	1·24	2·18	2·42	3·67	1·92	3·21	2·84	3·30	1·12
March, .	2·83	3·80	·41	2·70	1·60	1·45	1·50	·28	1·04
April, . .	3·10	1·60	1·65	·79	·70	2·00	1·35	·51	3·75
May, . .	·88	1·10	1·37	·80	·90	2·80	·80	2·57	·22
June, . .	1·53	1·84	2·20	2·36	1·35	2·20	2·41	1·92	·74
July, . .	2·21	4·01	·58	3·06	2·68	3·24	3·98	1·06	4·28
August, .	3·20	2·54	3·22	3·00	1·63	3·21	1·63	2·00	2·52
September,	1·95	1·44	2·74	1·47	1·28	1·89	1·70	1·22	1·93
October, .	2·61	5·98	5·33	3·25	‡3·78	§3·71	2·98	1·27	1·80
November,	*6·62	1·51	4·96	2·43	2·50	3·15	1·30	3·05	1·63
December,	4·22	1·62	3·10	4·60	1·18	1·18	1·92	‖ 4·57	·36
Greatest Daily Fall,	6·62	5·98	5·33	4·60	3·78	3·71	4·24	4·57	4·28
					4·37 Wast-dale.	4·69 Lang-dale.		5·74 Stone-thwaite.	

* On the 25th and 26th of November 1845, the fall at Seathwaite in 48 hours was 9·62 inches; and at Langdale Head, 8·89 inches!!!

1846. On the 2d and 3d of March, the fall at Seathwaite was 6·86 inches.

,, On the 8th and 9th of October, there fell 9·74 inches; and on the 8th, 9th, and 10th, 11·63 inches.

1847. On the 6th and 7th of October, the fall was 6·76 inches; and on 4 days in this month, it amounted to 13·10 inches.

,, On 2 days in November, there fell 8·36 inches; and on 2 days in December, 6·14 inches.

1848. On the 3d, 4th, and 5th of February, the fall was 7·72 inches; and on 9 days in this month, it amounted to 23·13 inches!!

,, On the 3d and 4th of October, the fall was 5·89 inches.

,, On the 3d and 4th of December, there fell 6·74 inches; and on the 3d and 26th the fall amounted to 8·82 inches.

† 1849. In January, the greatest daily fall at Langdale was 4·30 inches on the 24th; and in 3 days in this month, the deposit amounted to 8·68 inches.

‡ ,, In the 4 days between the 22d and 25th of October, the fall at Seathwaite was 10·79 inches;—the maximum daily fall at Wastdale Head was 4·37 inches, and from the 22d to the 25th inclusive, the deposit of rain amounted to 9·94 inches.

1850. On February 14, 15, and 16, the fall was 6·91 inches, and on 5 days in this month, it amounted to 12·72 inches.

§ ,, The greatest daily fall at Langdale, in October, was 4·69; on the 6th and 7th, the deposit amounted to 8·26 inches, and at Seathwaite to 5·91 inches.

,, On 4 days in November, there fell 10·00 inches.

1851. On January 1 and 2, the fall was 5·34 inches; and on 5 days in this month, it amounted to 14·98 inches.

,, On the 12th, 13th, and 14th of July, the fall was 8·27 inches.

,, On the 18th and 19th October, there fell 5·63 inches; and in 3 days in this month, 8·58 inches.

1852. On 3 days in January, the fall was 10·42 inches.

,, On the first 5 days of February, 11·15 inches was measured; and on 6 days in this month, 13·77 inches.

,, On the 10th and 11th of December, there fell 7·60 inches; and on 8 days in this month, 20·73 inches!!

‖ ,, The greatest daily fall at Stonethwaite in December, was 5·74 inches on the 11th; on the 10th and 11th, the deposit was 9·11 inches; and on 8 days in this month, it amounted to 20·97 inches!!

1853. Fall on 3d and 4th of July, 6·62 inches.

Remarks on the Year 1853.

January.—A mild and rather wet month. January is usually the coldest month, but, this year, it was considerably warmer than either February or March. The mean temperature was 2°·7 *above* its average value. There was thunder and lightning on 4 days, and the sun shone out more or less on 25 days in this month. On the 17th, I find the following memorandum in the Register,—"This is the first really clear and bright evening we have had since the 29th of November."

A correspondent of the *Whitehaven Herald* states that "the rain which fell on the 15th, in some parts of High Furness, was so black as to colour the mountain brooks, and even the earth and sand washed by the same had a dark appearance. This is not the first time that such a phenomenon has been observed. It has been previously witnessed, both in this district and in Norfolk. At the latter place, a farmer writing in the *Lynn Advertiser* stated, "that the rain which fell upon his newly-cut swathes made them so black, that the haymakers were like chimney-sweepers."

An Orange-tinted atmosphere.—Jan. 4th. Heavy rain throughout the day; about 4 P.M., fair, but sky overcast,—the whole atmosphere assumed an orange tinge, which had a very peculiar effect on surrounding objects, resembling the lurid aspect of the landscape during the continuance of a total or an annular eclipse of the sun.

February.—Fine, but very cold, with the thermometer at or below 32° on sixteen nights. The coldest February in the last 21 years, except the corresponding month of 1838. The mean temperature is 5°·4 *below* the average. On the 12th, at 8 A.M., the thermometer stood at 20°; at 11h. 30m. A.M., at 24°·5; and, at 3 P.M., at 26°—the mean temperature of the day being 23°·2. A naked thermometer on raw wool on grass, fell to 8°·7 on the night between the 27th and 28th. Snow fell on 5 days, and the entire depth was equivalent to a quarter of an inch of water.

On the evening of the 27th, the Zodiacal Light was unusually bright and distinct. The cone, or rather frustrum, was not visible much beyond the altitude of Saturn;—its sides, if prolonged, would apparently meet a little to the south of the Pleiades. At 9h. 30m., there was no trace of the light. From 8 P.M., there was a low flat auroral arch, altitude about 23°, and breadth 6°,—very bright and pretty well defined. The sun shone out on 23 days.

March.—A fine, dry, but cold month. Mean temperature 2°·3 *below* its average value. Snow showers fell on 6 days, and the entire fall was equal to $\frac{1}{10}$th of an inch of water. Lightning was seen on the evening of the 4th. The thermometer at 4 feet above the ground fell below 32° on 10 nights, and the sun shone out more or less on 28 days.

The Comet, supposed to be that of 1664, was seen at this Observatory on the evening of the 30th.

FIRST QUARTER.—The mean temperature of the quarter ending March 31st, is 1°·6 *below* the average of the previous 20 years. The deaths in the town and suburb of Preston Quarter are 127, being 24, or 16 per cent. *under* the average number in the last 14 years, corrected for increase of population.

By the Registrar-General's report it appears, that "the deaths throughout the kingdom in the first 3 months of this year *exceeded* by 11,559 the deaths in the winter quarter of 1852, and by still more the deaths in any previous winter, except the winters of 1847 and 1848, when influenza and cholera prevailed. On the average of the 10 winter quarters 1843–52, the rate of mortality was 2·467 per cent.; in the winter quarter of the present year 2·620 per cent."

April.—A fine seasonable month. Its mean temperature is *identical* with the average of the previous 20 years. The thermometer at 4 feet above the ground did not fall within 1½° of the freezing point, but a delicate instrument placed on wool on a grass plot, descended to 18° on the night common to the 8th and 9th. The sun shone out on 27 days.

On the 14th, I find the following entry in the journal:—"A blackbird's nest containing four and a thrush's nest with three eggs were found to-day near Bridge Foot. There are as yet but few indications of spring. The hedgerows are only beginning to bud, and the only green leaves visible are those of the wild gooseberry bush and woodbine. On warm banks primroses are expanding, and in considerable numbers. Bees have begun to bear within the last few days."

On the night of the 21st, a very fine, perfect, and sharply-defined *lunar* halo, about 44° in diameter, was almost continuously visible from 10h. to 14h. (2 o'clock in the morning.)

On the following day, there was a magnificent *solar* halo from 11h. 30m. A.M. till near sunset; at 3h. 30m. P.M., the interior dimensions of the ring taken with the altazimuth instrument, were,

Polar diameter, . 43° 17′,
Equatorial do., . 43° 50′,

From 5h. 45m. till near 6h. 30m., the ring was broken up into several segments, the upper one being by far the brightest, and exhibiting prismatic colours of considerable intensity. From this portion of the ring, two faint curved rays or bands of light were thrown off. At 5h. 45m., I noticed a faint mock sun, or circular patch of light much brighter than the ring, and intersecting it to the left of the sun, and nearly at the same altitude. The parhelion threw off outwards an elongated cone or bush of white light, and an imaginary line joining the axis of the bush and the centre of the parhelion and true sun was parallel to the horizon. The halo had vanished by 6h. 30m.; afterwards, a faint cone of light resembling the bush described might be traced above the sun's upper limb, perpendicular to the horizon. Soon after the moon rose, a faint *lunar* halo was visible, and it continued more or less perfect till after midnight. On the morning of the 28th, at 2h. 21m., an unusually brilliant shooting star appeared and disappeared in the south-east at an altitude of about 15°, and it conveyed a strong impression of being close at hand, as if it were a spark from a neighbouring chimney. At 2h. 30m., there was a singular brownish conical light above the upper limb of the gibbous moon, resembling the flame of a candle.

The cuckoo was heard at Rothersyke on the 24th, and swallows made their appearance in this neighbourhood a day or two later. I first noticed the Io butterfly on the 29th.

Between the 24th of March and the end of April, we were favoured with an uninterrupted continuance of the finest astronomical weather I almost ever remember, and during this period I was enabled successfully to measure, both in position and distance, some of the most delicate and difficult double and binary stars—as ϵ Bootis, ζ Bootis, and ζ Hercules.*

From the very favourable state of the atmosphere, I was also enabled to charge the micrometer with a lens of unusually high power (500) and of admirable workmanship, made by Mr Simms,—with which systems of the 3d and 4th magnitude (under illumination) presented perfect disks, with scarcely a trace of rings. Indeed, nothing could exceed the beauty and sharpness of the stellar definition with this eye-piece, and I prefer it to any lower power for micrometric measures, when the air is at all tolerably steady.

May.—The driest May on record at this place, except the corresponding month in 1836 and 1844. The entire deposit of rain between the 19th of April and the 6th of June—a period of 47 days, only amounted to 0·624 inch, of which 0·272 fell in May, on 6 days. The month was remarkably fine and clear throughout; the number of perfectly clear days was 7, and the sun shone out either partially or continuously on *every* day. The nights were cold, bright, and cloudless, and an enormous amount of radiant heat was thrown off from the earth's surface between sunset and sunrise. The difference between the day and night temperature was 17°; and the mean difference between the standard thermometer in air at 4 feet above the ground, and one on raw wool placed on the grass, was 14°·2. Vegetation was consequently subjected to very low temperatures:—the mean of the night temperature on the grass was 29°·8,

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* In about two years, the small purple companion of ζ Hercules will have performed two entire revolutions around its brilliant primary since its position was first determined by Sir W. Herschel in the summer of 1782. It is now moving in its orbit at the rate of about 5° per annum, and its distance has increased of late years.

or 2°·2 below the freezing point. The naked thermometer on wool frequently fell below 20°, and once to 17°, although the standard instrument did not descend below 35° during the month. The mean temperature is $\frac{3}{10}$ths of a degree *under* its average value. On the 7th, there were some slight snow showers, and between the 3d and 7th, the maximum temperature fell 15 degrees. On the 9th, there were 9 inches of snow on the ground between Keswick and Cockermouth. At Liverpool, snow covered the streets to the depth of 3 inches at 8 o'clock in the morning. At Holmfirth, snow fell heavily throughout the day,—it was 18 inches deep on the streets.

During this beautifully fine clear month, the astral definition was so deplorable, that only three sets of Positions were obtained at this Observatory in as many weeks, with the apparent advantage of an almost continuously bright and unclouded sky. The hygrometrical condition of the air was unusually low, the dew-point ranging from 12° to 24° below the temperature of the air. On the 13th, the complement of the dew-point was 17°·1; on the 15th, 20°·5; on the 17th, 22°·5; and, on the 24th, 24°·5,—approaching to the extreme of hygroscopic dryness in this climate.

To the very unequal distribution of moisture over the upper and lower strata of the atmosphere, the twirling, moulding, and blotted appearance of the stars is no doubt to be attributed.

The Cabbage Butterfly was seen on the 1st.

The Cuckoo was heard at Seathwaite on the 1st, and Swallows were seen on the 17th, for the first time this season. Snow fell in the Lake District on every day between the 6th and 9th inclusive, amounting to 0·35 inch of water.

June.—A fine but rather cold month. The temperature is half a degree *below* the average. The sun shone out on 28 days.

Second Quarter.—The temperature of the quarter ending June 30th, is 0°·3 *below* the average of 20 years. The deaths in the town and suburb are 99, being 23 in number, or 19 per cent. *under* the average of the 14 previous spring quarters. In the 1st and 2d quarters of the year 1853, the sanitary condition of Whitehaven is very favourably contrasted with that of the kingdom generally. The Registrar-General in his report for this quarter says:—"The average mortality for the spring quarter is 2·223. This average is exceeded by the present return, which shews a mortality at the rate of 2·383 per cent. per annum *higher* than the rate in the corresponding quarter of every year from 1843–52, except the spring quarter of 1847, when the population was infested by scurvy and its attendant diseases, after the great failure of the potato crop in 1846. The rate of mortality was then 2·506; in the autumn, influenza broke out, and cholera followed in its footsteps in 1848 and 1849."

July.—A cold, damp, and rather wet month. The mean temperature 1°·49 *below* the average, and 6°·1 under that of July 1852. A thunder storm occurred on the evening of the 13th, accompanied by heavy rain. The sun shone out on 24 days.

August.—A cool, but fine and dry month. Rain fell on 11 days only, and the sun shone out on every day but two. The temperature is 0°·7 *under* the average of 20 years, and 2°·17 under that of the same month in 1852.

The evaporation and rain fall are identical in amount (3·12 inches). The grain harvest commenced in this neighbourhood on the 19th.

The Comet discovered by Klinkerfues at Göttingen, on the 10th of June, suddenly became visible to the naked eye in its descent to the perihelion, on the evening of the 23d of August, about 8 o'clock. Owing to the almost continuous presence of cloud in the north-west, the comet was seen at this Observatory on two evenings only, those of the 23d and 26th. On the latter occasion, the nucleus was equal in lustre to a star of the first magnitude, and its well-defined parabolic tail was probably 6° or 8° degrees in length. The angle of Position of the axis of the tail with the meridian, by a mean of three observations secured through openings in the clouds, was found to be 60°·2. The nucleus of the comet was detected by Mr Hartnup of Liverpool, at mid-day on the 3d of September, when it attained the perihelion.

September.—A fine, dry, and seasonable month. The temperature is *identical* with the average of 20 previous years. The sun shone out on 25 days, and exactly half the entire number of days were free from rain. The evaporation and fall of rain again very nearly balance each other.

On the evening of the 2d, at 9 o'clock, there was a brilliant but irregular and imperfect Auroral arch at an altitude of 50°, in the direction of the magnetic east and west. The extremities were turned upwards towards the zenith. The phenomenon more resembled an illuminated white cloud, than the light usually exhibited by the Aurora Borealis. It disappeared in about 15m. after the writer's attention was first called to it, and was succeeded by volumes of auroral mist extending from east to west, which emitted faint magnetic flashes.

Third Quarter.—The temperature of the summer quarter is 0°·7 *below* the average of 20 years. The deaths in the town and suburb are 73, a *smaller number* than has been registered in any previous September quarter, except in 1852, when the deaths were exactly the same in number. The deaths are 43, or 36·7 per cent. *under* the corrected average number.

The rate of mortality for the entire kingdom was also *under* the average rate for the season.

October.—Mild and wet, more rain having fallen than in any other month of 1853. The temperature is 1°·8 *above* its average value. On the 29th, at 9 p.m., a single auroral streamer in WSW., extending to the zenith. The sun shone out on 23 days, although more or less rain fell on 24 days in the month.

November.—A mild month, and less damp than usual. The temperature is 0°·9 *above* the average, and the thermometer fell to the freezing point on *one* night only.

There were two lunar halos, and two slight appearances of aurora borealis.

December.—A fine and remarkably dry, cold month. The temperature is 4°·28 *under* the average, and no less than 8°·55 *under* the mean temperature of the corresponding month in 1852 ! ! This is the driest December on record at this place, except the corresponding month of 1844, in which the quantity of rain was only $\frac{3}{10}$ths of an inch. The Decembers of 1852 and 1853 are strikingly contrasted with each other ;—whilst the former was *the mildest and wettest*, the latter is *the coldest* (two excepted) *and driest* (one excepted) ever known, or at least recorded at Whitehaven. In December 1852, the depth of rain slightly exceeded 11 inches ;—in the same month of 1853, it only amounted to half an inch. The sun shone out on 15 days, and the thermometer fell below 32° on 14 nights.

On the 6th, at 7h. 25m. P.M., there was an auroral arch, 10° or more in breadth, extending from ENE. to WSW., the centre passing a little south of the zenith. At 8 P.M., two-thirds of the sky were covered with streamers converging about 15° south of the zenith. By 8h. 30m. the phenomenon had nearly disappeared. At 11h., there was a broad arch in the NW.—altitude of centre about 30°.

Last Quarter.—The mean temperature of the last quarter is 0°·5 *under* the average. The deaths in the town and suburb are 138, or three *above* the corrected average number in the 14 previous autumn quarters. The prevailing disease was Scarlatina. Whitehaven was entirely exempted from cholera, which visited the adjacent town of Workington with fatal virulence during this period.

According to the Registrar-General, " this period was unhealthy, and a greater number of lives was lost to the population than in any other autumnal quarter of the last 13 years, with only two exceptions,—the fourth quarter of 1846 and that of 1847."

Winds.—In 1853, the winds were distributed as under :—N., 33 days ; NE., 62½ days ; E., 26½ days ; SE., 26½ days ; S., 57 days ; SW., 92 days ; W., 31 days ; and NW., 36½ days.

Weather, &c.—In the bygone year, there were 21 *perfectly clear* days ; 152 days more or less cloudy without rain ; 192 wet days ; 300 days on which the sun shone out more or less ; 46 frosty nights (of which 16 were in February and 14 in December) ; 15 snow showers ; and 11 days on which hail fell. There have also been 2 solar and 6 lunar halos, 1 parhelion, 4 days of thunder and lightning, 1 day on which lightning was seen without thunder, and 7 appearances of aurora borealis. The number of days on which the sun shone out is greater than in any other year of which a record has been kept. The next greatest number was 292, in 1844.

The mean temperature of the year 1853 is 48°·11, being 0°·79 *below* the climatic average of this place, and 2°·04 *below* the temperature of the year 1852. The fall of rain is 9·18 inches *under* the average depth in 20 years, and 12·63 inches *under* the quantity measured in 1852. There are but two years in the last 21 which exceed the past in dryness,—viz., 1842 and 1844; in the former, the fall of rain was 34·70 inches, and, in the latter, 36·72 inches.

The last two years present several abnormal and very opposite characteristics. On the whole, the year 1852 was one of the *wettest*, —while 1853 was one of the *driest* on record at this port; yet, in both years, the fall of rain in the first 6 months was greatly below the normal depth. The year 1852 was one of the *mildest*, and 1853 one of the *coldest* in the last 21 years. In 9 months of 1852, the temperature was considerably *above*,—and, in 8 months of 1853, it was greatly *below* the average for the season. The year 1852 was remarkable for the *unusual number* and almost tropical severity of its thunder-storms,—the year 1853 is equally marked by an *extraordinary absence* of electrical disturbances in the atmosphere, the number of thunder-storms being only four, (of which three occurred in January) and none of them were of a violent character. The month of December, 1853, was moreover entirely exempted from the tremendous gales of wind which prevailed towards the close of the year 1852.

In 1852, the amount of surface evaporation was 30·34 inches; in 1853, the depth is 27·33 inches.

In March, May, June, August, and December, 1853, the evaporation *exceeds* the fall of rain; in April and September, the two processes nearly balance each other; and, in the other months of the year, the depth of water precipitated greatly exceeds the amount of spontaneous evaporation.

The deaths in the town and suburb in 1853, are 437, being 89 in number, or 17 per cent. *below* the average annual number in 14 years, corrected for increase in population. The births (689) exceed the deaths by 252, and are eight above the corrected average number for the same period.

Assuming the population of the town and suburb of Whitehaven to be the same as in 1851 (19,281), when the last census was taken, the mortality is equivalent to 22·6 deaths per 1000, or one death in every 44 inhabitants. This rate is favourably contrasted with the ratio of mortality in most of the principal towns of the kingdom during the past year. In Glasgow, the mortality amounted to 26·9 deaths in every 1000 persons, a considerably greater mortality than in 1848, when the city was infested with cholera. Nearly 50 per cent. of the deaths were those of children under 5 years of age.

The sanitary condition of this town has been rapidly improving every year since the water-works were completed in 1851. In

1849, the mortality was equivalent to 32·2 deaths per 1000, or one in every 31 persons; in 1850, to 24·9 deaths per 1000, or one in every 40 individuals; in 1851, to 23·4 deaths per 1000, or one death in every 42·6 inhabitants; in 1852, to exactly 23 deaths per 1000, or one in every 43·3 persons; and, in 1853, the mortality was at the rate of 22·6 deaths per 1000, or one death in every 44 inhabitants. The average number of deaths in the 14 years ending with 1852, is 495, which, with an assumed mean population of 18,143, gives 27·2 deaths per 1000, or one in every 36·6 persons.

According to the Registrar-General, the annual average rate of mortality for the kingdom, from 1843 to 1852, is, in towns, 25·8 per 1000, and in the country districts, 20·3 per 1000 persons. These figures shew that, prior to 1850, the rate of mortality in Whitehaven was not only absolutely excessive, but relatively so to that of the principal towns in England.

The tables showing the annual, monthly, and maximum daily fall of rain at Seathwaite, in the heart of the English Lake District, during the last nine years, require very little comment. The greatest fall *in any year* was 160·9 inches, in 1847,—the least, 113·7 inches, in 1853.

The greatest *monthly* fall was 32·83 inches, in December 1852. The greatest depth measured *in 24 hours* was 6·62 inches, in November 1845; and, *in 48 consecutive hours*, 9·62 inches, on the 25th and 26th of November, 1845, and 9·74 inches on the 8th and 9th of October, 1846.

The Observatory, Whitehaven,
28th January 1854.

The Great Auk still found in Iceland.

The Great Auk (*Gar-Fogel*, Sw.; *Alca impennis*, Linn.) This remarkable bird—the largest of its tribe, being the size of the common tame goose—which at no period of its existence is able to fly, resembles greatly the penguins of the southern hemisphere, the link between birds and amphibious animals. Although at one time, according to ancient authors, it belonged to the Scandinavian fauna, it cannot now be considered as entitled to a place there. The last heard of on the coast of the peninsula was killed in the Cattegat, near to the town of Marstrand, some fifty or sixty years ago. About the same period, Denicken tells us, one was shot in the harbour of Keil, in Holstein.

According to Graba, the Great Auk has not been seen in Greenland, Iceland, or the Faroe Islands of late years; and the author of an article in the *Edinburgh Cabinet Library*, who cites Graba, says that "the race may now be regarded as extinct." English and Swedish naturalists, as respects the countries in question, seem to have come pretty much to the same conclusion. But this is incorrect; for on parts at least of the coast of Iceland it is still to be met with. This is more especially the case on the so-called *Geirfugle-Skyaer* (Danish), or Great Auk-Skär; on which, however, so fearful a surf is said constantly to beat, that it is rarely, excepting at imminent risk to life, that a landing can be effected.

In the year 1813, a colony of these birds, we are told, were here observed by a passing ship. A boat was at once despatched to the spot, and no fewer than twenty were captured on their eggs, all of which were carried to Reckravig. One of the birds was afterwards stuffed, but the others were eaten. In 1814, again, eight individuals were killed on a flat skär, on the west coast of Iceland. In 1818 a single one was taken at a place in South Iceland, where several others were also observed. In 1823 two old birds were killed on a skär near to Orebakke, and both were sent to the Royal Museum in Copenhagen. In 1829 a pair, male and female, were killed on the Geirfugle-Skyaer, whilst courageously defending their two eggs (they usually lay but one). The birds are now in the possession of the apothecary Mechlenburg, at Flensborg. Still later, in 1832, at least ten were killed on a skär near to Iceland. In the year 1834, three birds and three eggs were brought to Copenhagen from that island. In 1844 two birds and two eggs also reached this city from the same quarter. People whose word is to be relied on, Kyaerbolling tells us, have informed him, that birds have subsequently been seen off the coast of Iceland; but although a large reward has been offered for both birds and skins, no one has had the courage to land upon the skär.

From the above account there can be little question as to the Great Auk still existing in some numbers on the coast of Iceland; and I doubt not that we shall one day hear of some of our enterprising countrymen having overcome all difficulties, and returning home with a rich booty.

The egg of the Great Auk (occasionally it lays two, as it would seem from the foregoing) is about the size of that of a swan, and in shape it resembles that of the Foolish Guillemot, but is less pointed. The ground colour is dirty white, tinged with yellow, marked, especially at the thicker end, with black-gray and brown blotches and streaks.—*L. Lloyd's Scandinavian Adventures*, vol. ii., p. 495.

On the Food of Man under different conditions of Age and Employment. By Dr Lyon Playfair, C.B., F.R.S.*

The author commenced by adverting to our very imperfect acquaintance with the statistics of food. We are still ignorant regarding the quantity of the different proximate constituents of aliment necessary for man's sustenance, even in his healthy and normal condition. If the question were asked—How much carbon should an adult man consume daily?—there would be scarcely more than one reliable answer, viz., that the soldiers of the body-guard of the Duke of Darmstadt eat about 11 oz.† of carbon in the daily supply of food.

If, again, the question were asked—How much flesh-forming matter supports an adult man in a normal condition?—no positive answer could be given. Even, as respects the relation between the carbon in the flesh-forming matter and that of the heat-givers, we have no reliable information. It is true that certain theoretical conclusions on this head have been drawn from the composition of flour, but no real statistical answer deduced from actual experience exists.

When we inquire into the cause of our ignorance on these points, it is found that the progress to knowledge is surrounded with difficulties. Neither chemistry nor physiology is in a sufficiently advanced state to grapple satisfactorily with the subject of nutrition. For example, we

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* From the Proceedings of the Royal Institution of Great Britain in 1853.

† Liebig states a higher amount, but this is a recalculation from the new food tables.

know that albumen in an egg is the starting-point for a whole series of tissues; that out of the egg come feathers, claws, fibrine, membranes, cells, blood, corpuscles, nerves, &c., but only the result is known to us; the intermediate changes and their causes are quite unknown. After all, this is but a rude and unsatisfactory knowledge. Hence, when we approach the subject it is only to deal with very rough generalities. Admitting that the experience of man in diet is worth something, it is possible to arrive at some conclusions by the *statistical* method,—that is, by accepting experience in diet, and analyzing that experience. Take, for example, the one general line of pauper diet for the English counties placed in the table at the end of this notice. The mode of arriving at the result of experience, in the case of paupers, was to collect it from *every* workhouse in the kingdom, and then to reduce it to one line. But the labour of this is immense. In the preparation of this one line the following work had to be performed in acquiring the data:—

Number of Unions applied to, . . .	542
Number of explanatory letters sent to them, .	700
Number of calculations to reduce the results, .	47,696
Number of additions of the above calculations, .	6,868
Number of extra hours, *beyond the office hours*, paid to a clerk for the reduction, . .	1,248

The statistical method, besides being very laborious, is extremely tedious, and has thus deterred persons from encountering it. In giving, therefore, an example of some of the results which have been collected within the last few years, they will represent much labour, but very little or no originality.

The lecturer then alluded shortly to the conditions in nutrition, which must be borne in mind in looking at these results. It was now admitted that the heat of the body was due to the combustion of the unazotized ingredients of food. Man inspires annually about 7 cwt. of oxygen, and about $\frac{1}{5}$th of this burns some constituent and produces heat. The whole carbon in the blood would thus be burned away in about three days, unless new fuel were introduced as food. The amount of food necessary depends upon the number of respirations, the rapidity of the pulsations, and the relative capacity of the lungs. Cold increases the number of respirations and heat diminishes them; and the lecturer cited well-known cases of the voracity of residents in Arctic regions, although he admitted, as an anomaly, that the inhabitants of tropical climates often shew a predilection for fatty or carbonaceous bodies. He then drew attention to the extraordinary records of Arctic dietaries shewn in the table, which, admitting that they are extreme cases, even in the Arctic regions, are nevertheless very surprising.

Dr Playfair then alluded to the second great class of food ingredients, viz., those of the same composition as flesh. Beccaria, in 1742, pointed to the close resemblance between these ingredients of flesh, and asked, "Is it not true that we are composed of the same substances which serve as our nourishment?" In fact, the simplicity of this view is now generally acknowledged; and albumen, gluten, caseine, &c., are now recognised as flesh-formers in the same sense that any animal aliment is. After alluding to the mineral ingredients, attention was directed to a diet-table, which contained some modifications, but was based on the one published in the *Agricultural Cyclopædia* under the article *Diet;* the table as shewn being used in the calculation of the dietaries.

The old mode of estimating the value of dietaries, by merely giving the total number of ounces of solid food used daily or weekly, and quite irrespective of its composition, was shewn to be quite erroneous; and an instance was given of an agricultural labourer in Gloucestershire, who in the year of the potato famine subsisted chiefly on flour, consuming 163 ounces weekly, which contained 26 ounces of flesh-formers. When potatoes cheapened he returned to a potato-diet, and now ate 321 ounces weekly, although his true nutriment, in flesh-formers, was only about 8 or 10 ounces. He shewed this further, by calling attention to the six pauper dietaries formerly recommended, to the difference between the salt and fresh meat dietary of the sailor, &c., all of which, relying on absolute weight alone, had in reality no relation in equivalent nutritive value.

Attention was now directed to the diagrams exemplifying dietaries. Taking the soldier and sailor as illustrating healthy adult men, they consumed weekly about 35 ounces of flesh-formers, 70 to 74 ounces of carbon; the relation of the carbon in the flesh-formers to that of the heat-givers being 1 : 3. If the dietaries of the aged were contrasted with this, it would be found that they consumed less flesh-formers (25—30 ounces), but rather more heat-givers (72—78 ounces); the relation of the carbon in the former to that of the latter being about 1 : 5. The young boy, about ten or twelve years of age, consumed about 17 ounces weekly, or about half the flesh-formers of the adult man; the carbon being about 58 ounces weekly, and the relations of the two carbons being nearly 1 : 5½. The circumstances under which persons are placed influence these proportions considerably. In workhouses and prisons the warmth renders less necessary a large amount of food-fuel to the body; while the relative amount of labour determines the greater or less amount of flesh-formers. Accordingly, it is observed that the latter are increased to the prisoners exposed to hard labour. From the quantity of flesh-formers in food, we may estimate approximatively the rate of change in the body. Now, a man weighing 140 lb. has about 4 lb. of flesh in blood, 27½ lb. in his muscular substance, &c., and about 5 lb. of nitrogenous matter in the bones. These 37 lb. would be received in food in about eighteen weeks; or, in other words, that period might represent the time required for the change of the tissues, if all changed with equal rapidity, which is, however, not at all probable.

All the carbon taken as food is not burned in the body, part of it being excreted with the waste matter. Supposing the respirations to be 18 per minute, a man expires about 8·59 oz. of carbon daily, the remainder of the carbon appearing in the excreted matter.

In conclusion, Dr Playfair explained how the dietary-tables elucidated the various admixtures of food common to cookery, and how they might even be made to bear on certain national characteristics, which were in no small degree influenced by the aliments of different nations.

Examples of Dietaries as

	Weight in ounces per week.	Nitrogenous ingredients.	Substances free from Nitrogen.
Dietaries of Soldiers and Sailors—			
English Soldier	378	36·15	127·18
Do. in India	261	34·15	103·19
English Sailor (Fresh Meat)	302	34·82	102·89
Do. (Salt Meat)	290	40·83	132·20
Dutch Soldier, in War	198	35·21	102·08
Do. in Peace	383	24·52	106·80
French Soldier	347	33·24	127·76
Bavarian do.	242	21·08	102·10
Hessian do.	423	23·0	136·0
Dietaries of the Young—			
Christ's Hospital, Hertford	216	17·16	61·27
Do. London	242	17·27	76·82
Chelsea Hospital, Boys' School	245	12·89	93·28
Greenwich Hospital, do.	231	18·43	86·73
Dietaries of the Aged—			
Greenwich Pensioners	269	24·46	122·21
Chelsea do.	332	29·95	112·64
Gillespie's Hospital, Edinburgh	156	21·02	92·32
Trinity Hospital, do.	192	19·63	97·34
Old Pauper Dietaries—			
Class 1	...	20·21	88·61
„ 2	...	14·96	89·59
„ 3	...	15·78	99·88
„ 4	...	19·22	116·84
„ 5	...	15·49	96·51
„ 6	...	14·67	88·03
Average of all English Counties in 1851	...	22·0	99·0
St Cuthbert's, Edinburgh	175	14·80	89·37
City Workhouse, do.	107	13·30	49·99
English Prison Dietaries—			
Class 2, Males	206½	15·28	111·85
„ 3, do.	276	18·26	123·60
„ 4, 7, & 8. do.	271½	20·97	125·98
„ 5, do.	326	20·29	130·57
Bengal Prison Dietaries.			
Non-Labouring Convicts	224	18·43	163·16
Working Convicts	296	28·16	191·12
Contractors' insufficient Diet	167½	12·70	135·95
Bombay Prison Dietaries—			
All Classes of Prisoners not on hard labour	182	28·00	101·50
Hard Labour	224	35·63	128·80
Arctic and other Dietaries—			
Esquimaux	...	250·0	1280·0
Yacut	...	999·0	640·0
Bosjesman	...	574·0	368·0
Hottentot	...	424·0	400·0
Agricultural Labourer, England	163·6	26·64	106·57
Do. do.	114·6	20·39	72·46
Do. India	218·0	14·02	138·27

shewn in the Diagrams.

Mineral matter.	Carbon.	Proportion between: Carbon in flesh formers.	Carbon in heat-givers.	REMARKS.
4·92	71·68	1	3·66	Public Dietaries.
2·39	66·32	1	3·58	
3·17	70·55	1	3·70	
6·03	87·40	1	3·94	
1·85	74·08	1	3·87	MULDER.
4·15	70·77	1	5·32	
4·62	85·25	1	4·72	Special Return obtained.
3·32	62·45	1	5·47	
...	77·0	1	6·16	LIEBIG.
2·47	39·18	1	4·21	Special Returns obtained.
2·84	46·95	1	5·02	
5·93	57·67	1	8·29	
2·62	52·87	1	5·29	
3·54	72·43	1	5·46	Special Returns obtained.
4·65	78·03	1	4·80	
2·35	71·39	1	6·26	
3·33	57·30	1	5·38	
3·27	54·30	1	4·95	The 6 dietaries recommended as equivalent by the Poor-Law Commissioners.
2·89	51·10	1	6·31	
3·91	55·43	1	6·50	
3·96	67·87	1	6·50	
3.58	54·72	1	6·53	
2·84	49·57	1	6·25	
...	58·0	1	4·85	Specially reduced from all the Unions in 1851.
3·31	46·98	1	5·85	Special Returns.
1·74	31·48	1	4·36	
3·46	59·23	1	7·13	Convicted Prisoners exceeding 7 days, but not exceeding 21 days.
4·05	67·53	1	6·81	Convicted Prisoners, hard labour, exceeding 21 days, but not more than 6 weeks.
5·03	69·88	1	6·13	Convicted Prisoners, hard labour, above 6 weeks, and not more than 4 months.
4·23	73·31	1	6·65	Convicted Prisoners, hard labour, for terms exceeding 4 months.
2·08	76·35	1	7·62	From information supplied from the India House.
2·97	91·07	1	5·96	
1·30	61·33	1	8·88	
2·03	68·81	1	4·52	
2·45	87·22	1	4·50	
...	1125·0	...	...	These probably represent extreme cases mentioned by the following authorities. Ross, 1835, p. 448; Parry, 1823, p. 413; Cochrane, p. 255; Saritcheff. Barrow, pp. 152, 258; Richardson, *vide* Agric. Cyc., article *Diet.*
...	966·0	...	...	
...	555·0	...	...	
...	604·0	...	...	
1·10	74·70	...	...	Gloucestershire — See Agric. Cyclopædia.
1·18	51·72	...	...	Dorsetshire — See Agric. Cyclopædia.
2·41	61·54	...	...	Dharwar, Bombay—Return in Bombay Prison Dietaries.

Description of Two Caves in the North Island of New Zealand, in which were found Bones of the large extinct wingless Bird, called by the Natives, Moa, and by Naturalists Dinornis; with some general Observations on this Genus of Birds. By ARTHUR S. THOMSON, M.D., Surgeon of the 58th Regiment. Communicated by the Author.

Narrative.—In the month of February 1849, I accompanied Lieutenant Servantes, of the 6th regiment, Captain Henderson, Royal Artillery, and Lieutenant Clark, Royal Engineers, in search of a cave said to contain the bones of the Moa. Almost fifty years had elapsed since our guide, an old woman, had seen these bones. The place of the cave, and the bones, were perfectly familiar to her mind, as she had seen them when a girl, but the face of the country had evidently changed considerably since that period;—trees had grown up where ferns had formerly grown, and fern was now growing where trees then stood; so that after searching about for a whole day, the old lady was obliged to acknowledge that she could not find the cave, and we returned to Auckland without accomplishing the object of our journey.

In September 1849, I accompanied Captain Henderson and Lieutenant Servantes on another trip for a similar object; on this occasion we were successful in finding a cave, and a quantity of Moa's bones, among which were several almost entire skulls, and the beaks of some of the largest birds, and a bone like a humerus. These specimens were given to His Excellency Sir George Grey, Governor of New Zealand, who transmitted them, I believe, to Professor Owen.* I have been several times asked for a description of the cave, but as our visit to it was a hasty one, and as all my fellow-travellers to whom I might have applied for assistance in this matter had left the country, I was obliged to acknowledge my inability to give a satisfactory account of the cave. This I regretted very much, because the New Zealanders are exceedingly jealous of shewing or allowing any place to be-

* An account of these bones is given, I believe, in the Transactions of the Zoological Society, and forms Part V., in continuation of Professor Owen's previous memoirs on the Dinornis.

A. Thomson M.D. 58th Regt. del.

Schenck & McFarlane, Lith. Edin.

The Moa Cave, New Zealand

come known, which they have an idea is curious, without payment; and when I recollected the difficulty and the delay that we had experienced in finding the cave before, I knew that I could not find the place again without assistance, and a native of Auckland had refused to conduct me to the cave because the bones that were in it had been sold to a European, and I was aware that several bones from that cave had been sold at an extravagant price at Taranaki; consequently the place was, to the few who knew it, a species of gold mine.

I was anxious, however, to try and find the cave again; so partly with this object in view, and also to visit Taupo, I set out with Major Hume and Captain Cooper of the 58th regiment, in October 1852. We directed our steps to Parianiwaniwa, a village upwards of a hundred miles from Auckland, near to which the Moa cave is situated.

When passing through a forest between Raraoraro and Rotomarama, we were overtaken by a native driving a pig. We knew him to be partial to Europeans, because he had a gun-swivel hung from a hole in his right ear, as an ornament, and he had on his feet a pair of Blucher boots, which, from their dilapidated condition, were evidently worn more for ornament than use. After keeping up with him for some time, chiefly to admire how he got his pig through a most intricate path in the wood, the animal appearing to understand perfectly what he said, we entered into conversation about the price of his pig; and we asked him if he knew any caves near his village, which contained Moas' bones. This question made him stop, and turn round and look at us all. It would be something like asking a pig-driver near the quarry in Tilgate Forest in Sussex, if he had ever heard of the fossil remains of the Iguanodon Hylæosaurus, and other stupendous creatures made known to us chiefly by the industry of Dr Mantell. The English pig-driver would likely infer that the querist had escaped from a madhouse, because he was asking about things which he had never heard of; but not so with the New Zealander, acquainted with every tree in the forest, and every insect in the gronnd: he at once comprehended the question and replied, "I will shew you a cave which contains Moas' bones, for two sticks of tobacco."

The day after our arrival at the village of Rotomarama was Sunday, and one of our party went to prayers with the natives. In the evening our tent was filled with visitors, and early on Monday morning our party started for Manea, where we breakfasted.

General Description of the Country in which the Caves are found.—On the western coast of the north island of New Zealand, between the Mokau river and Taranaki, on the south, Kawhia on the north, and extending inland with occasional breaks to the Waipa river, there is an extensive district, chiefly composed of marine limestone. The formation is found in some parts on a level with the sea, and in other parts it has been elevated by volcanic action into mountain ranges and districts upwards of a thousand feet above the oceanic level. The rock occurs in strata. The stratification is sometimes twisted and broken, with bold cliffs and chasms of calcareous rock, presenting a highly picturesque effect, seen on passing along the path from the Waipa river to Parianiwaniwa. I could not ascertain the nature of the rocks upon which the limestone rests, but above it, in many places, there is nothing but alluvial deposits of earth, clay, sand, &c. At the bottom of the valleys the quantity of this aqueous deposit is very considerable; but occasionally on the slopes and sides of the hills, the limestone crops out in well-marked strata, presenting to the eye at a little distance the appearance of an old Gothic castle in ruins, or an ancient graveyard. With these exceptions, the hills present a smooth and rounded form, very unlike the volcanic hills in the neighbourhood. The soil on this limestone formation is covered with ferns, and occasionally large dense forests of trees. There are numerous caves, and grottoes, and cells, all over the district. Streams of water are seen to disappear between limestone rocks, and suddenly to reappear; fissures are found in which no erosions from water can be traced; but in all the caves and cells that I examined there was evidence of a rent, and also of watery erosion. These caverns in the earth have been long known to the New Zealanders in this part of the country; and near Kawhia there is a cave which was the burial-place of the Ngatitoas, the tribe of the great Rauparaha. Dieffenbach considers that the limestone formation belongs to the tertiary series.

Description of the Cave called by the New Zealanders Te Anaotemoa, or the Cave of the Moa.—This cave is situated near the summit of a small hill, about a mile and a half in a south-westerly direction from the village of Parianiwaniwa. The settlement is seventeen miles from Honi-Paka, a place on the Waipa river. The country in the neighbourhood of Parianiwaniwa is about a thousand feet above the level of the sea. Parianiwaniwa signifies, in the Maori language, "the precipice of the rainbow." The cave of the Moa is in a limestone hill, with two openings,—one towards the north-east, and the other towards the south-west. The north-east opening has evidently resulted from the falling in of the roof, and is apparently of a recent occurrence; the south-west entrance is fourteen feet high, and ten feet broad, and covered over with trees and bushes, which we had to break down before we got an entrance. The cave is 165 feet long, the greatest breadth 28 feet, and the height 60 feet. The roof is oval, and numerous stalactites drop gracefully from it, giving a cathedral-like effect to the whole. The cave is something in the form of a crescent; one part of the floor is covered over with calcareous spar; another part with a large deposit of soft stalagmites; and that part of the floor farthest distant from the south-west opening is covered with earth, limestones, and mud, which appear to have fallen down when the roof of the cave gave way, which now forms the north-east opening.

It is under this earth, and the soft deposit of carbonate of lime, that the Moa's bones are found. At the south-west entrance there is a mound of earth which has either fallen from the roof, or been washed in. The air of the cave is colder than the atmosphere, and the bottom or floor descends as you proceed from this entrance. There was not much dropping of water from the roof when we were there, but this must have been very considerable at one time, to have produced the large deposit of soft limestone which we saw in some places. The limestone in the cave is of a dark colour, and there is a shallow pool of water in one of the side galleries. All the bones we got were obtained from under the earth, which had fallen down, and partially imbedded them in the soft limestone; but it would require several days' labour of a number of men to clear out the bottom of this cave properly, in order to see what bones it contains; but so far as we saw there were no bones of men, or other animals (except Moas), in it; nor any marks of fire, sculpture, nor figures of any description on the walls of the cave.

It is evident that this cave has been long known to the New Zealanders; the very name, "the cave of the Moa," suggests to the mind the question, Was that name given to it because Moas lived in it, or because it contained large quantities of Moas' bones? My own opinion is, that it derived its name from the latter circumstance; for we were told on our first visit, that the Maoris were in the habit of resorting to this cave to procure the skulls of the Moas, to keep the powder which they used for tattooing. We only got four skulls in this cave, and the scarcity of them was accounted for by their use in former days as powder-holders. There was nothing to lead us to think that these bones had been deposited in the cave by water, for we found a remnant of almost every bone in the body, from the spine and the rings of the trachea down to the last bone of the toes; the bones belonged both to the largest and also to the smaller species of Moas. The animals evidently came to this cave to die. The cave, in the first instance, was probably a fissure in the stone, but from the appearance of the walls, and from there being numerous small cavities communicating with each other, I think its formation may have been assisted by the erosion of water. The bones we got in this cave had the appearance of having been exposed to the air; some of them were incrusted with limestone, and in some of them the cancellated structure was filled with earth and carbonate of lime; some of the bones had a more recent-like appearance than others, and the perfect edges of some of the delicate processes shewed that they had been exposed to little rolling: there were few long bones in the cave; and on our asking what had become of them, we were told that they had been taken away to be made fish-hooks of, such being the practice in former times, before the introduction of iron.

A sketch of this cave accompanies this paper.—(Plate II.)

Description of the Cave called by the New Zealanders Te Anaoteatua, or the Cave of the Spirit; in which Moas' bones were found.—This cave is about a mile from the native settlement of Rotomarama, on the path leading to Raraoraro, It is situated at the bottom of a hill, in a stratified rock, the entrance to which is 25 feet high, and 18 feet broad, of an oval form, and in appearance something like the gateway of an old castle. A thick foliage of shrubs conceals the entrance, and a dark green creeper adheres to the limestone rock, and covers the opening. The cave extends in a tortuous direction underneath the hill for upwards of a mile, and consists of several different passages. We reached the end of one of these passages after having traversed along for half a mile, according to measurement; but the largest we left unexplored. From the top and sides of the cave there are numerous stalactites—some of them six feet long, and composed of transparent calcareous spar, while others had a red tint. In that part of the cave which we explored there were three openings in the roof, at different places, of from ten to fifteen feet each in circumference, through which light was seen streaming in, one hundred and fifty feet above the head. Immediately below these openings there were heaps of wood and debris washed down from the surface; but these openings did not throw much light into the cave, so that even during the day the cavern was perfectly dark. There are numerous spacious chambers, picturesque galleries, grottoes, and cells, in different parts of the cave. The height of the roof is fifty feet in some parts, and in other places not more than ten feet; the breadth varies from twelve to forty feet. I saw no living creature in the interior of this cave but a few glow-worms, which adhered to a high dome-shaped part of the roof, and presented the appearance of the starry firmament. The floor of the cave is made up of different materials; parts are composed of calc-spar, parts are covered with a thick crust of soft limestone deposited from the overcharged water; and there are many large masses of limestone which have fallen from the roof. There are also large pools of stagnant water in some parts of the cave, and a subterraneous stream of water runs through a certain portion of the cave, and then disappears under the rock. There was no opening at the other extremity of the cave opposite the entrance, but there was an opening at the end of one of the passages, which was almost blocked up with earth, and the water in the cave had a sweet taste. There was no evidence of art about this cave, but I saw large pieces of charred wood on the floor, which I found, on inquiry, was burned three years before, when the natives obtained some of the Moa's bones, which they sold to us at Parianiwaniwa. The cave appears to have been formed by a fissure in the rock, the erosion of water, and by the falling down of the sides and roof. No plants were seen growing in the cave, and no shells were found; the air was good, although colder than the external atmosphere.

The Moa's bones which were procured from this cave were found, some under the sand, some in crevices and corners, and some under the limestone floor. They were broken, and shewed evidence of having been rolled; but we were afterwards told (when they refused to let us visit the cave again) that bones are to be found in the farthest extremity of the cave, under sand and soft limestone, and that the natives had obtained many bones here some years ago, which were burned because they saw no use of them. Among them was the pelvis and spinal column all adhering; several of the bones we got were covered with a crust of limestone. In a crevice of the cave, in one of the galleries, slightly covered with sparry limestone, we picked up a most perfect skull and a few bones. This skull is unknown to me. It differs from all the Moa's skulls that I have seen, although I think it belongs to the genus Dinornis. I shewed it to Governor Grey, who informed me that he could not say what bird it was the skull of. I have transmitted it, therefore, with this paper, for examination.*

I have already mentioned in the narrative, that we were unable to visit this cave a second time, to prosecute our researches; but I have little doubt, if this were properly gone about, many bones would be found there; for perhaps the Moas resorted to this cave as a place of refuge. All the bones that we got here had been evidently washed from the interior of the cave, or into the cave by water.

Before the introduction of Christianity, this cave—"the cave of the Spirit of God"—was held in the greatest terror

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* This skull is in the possession of James Thomson, Esq. of Glendowan, 37 Moray Place, Edinburgh.

by all New Zealanders. The love of money made some Christian natives conquer their fears, and enter the cave three years ago to look for Moas' bones; but the examination was apparently made in a very hasty and imperfect manner. It was in such gigantic caves as this, that the richest harvest of fossil and sub-fossil bones have been found in Europe, South America, and Australia.

History of the Discovery of the Bones of the Moa, and the Characters of the Genus Dinornis.—In the late Sir Robert Peel's gallery of "modern worthies" at Drayton Manor, there hangs a portrait of Professor Richard Owen, and in his hand is depicted the tibia of a Moa. This is a just and appropriate connection; for to the original mind of Mr Owen the world is indebted for the first hint of the existence of this gigantic bird. The discovery was made in this manner. In 1839 a Mr Rule lent Professor Owen a part of the thigh-bone of a Moa, which had been obtained in New Zealand, and from this single fragment he drew up a wonderfully correct notice of the bird. This memoir was sent out to New Zealand, and distributed among some of the missionaries. In the Tasmanian Journal* for 1843, there appeared a very excellent account, by the Rev. Mr Colenso, of some Moa's bones which he had obtained in New Zealand; but I was struck, on reading this paper, to find no mention made of Mr Owen's memoir, which was entitled "Notice of a Fragment of the Femur of a gigantic Bird in New Zealand." Since then Professor Owen has contributed, in several papers, observations on the Moa, which papers were founded on the collections of bones sent to England by Archdeacon W. Williams, Dr Mackellar, Mr Percy Earl, Colonel Wakefield, Mr Walter Mantell, and others. It is worthy of mention in this place, that not the least curious object in the Museum of the Royal College of Surgeons in London is the skeleton of this feathered giant, built up from some of these materials by Mr Owen.

The Moa belongs to the Struthious order of birds, a family

* This journal was originated and supported by Sir John Franklin, when Governor of Van Diemen's Land.

distinguished by having very short or rudimentary wings and massive legs. In their habits they are strictly terrestrial; and this will be at once comprehended, when I mention that in this order we find the Ostrich, the Cassowary, the Rhea, the Emu, the Apteryx, and perhaps the Dodo.

Bones of five different species of Moas have been found in New Zealand. The scientific term Dinornis is applied as a general term to the whole of them; and we have the Dinornis robustus, Dinornis struthioides, Dinornis dromioides Dinornis curtus, and Dinornis didiformis. But there are found in New Zealand, side by side with the large Moa's bones, the bones of other birds nearly allied to the Moa, although of less magnitude. The New Zealanders call them all Moas' bones; but naturalists denominate the largest as the bones of the Palaptyrix, the next as the Aptornis, of which there are two species, and the smallest bones are called the Notornis; and those who are curious about the distinguishing features of each, I beg to refer to Mr Owen's papers. A specimen of the last species of these birds was caught alive in a remote, unfrequented part of the south island of New Zealand, in 1850, by some sealers, and kept alive for several days, and afterwards killed and eaten; but, fortunately, the skin of this interesting bird, the link between the living and the dead, the last perhaps of a race coeval with the gigantic Moas, was preserved from destruction by Mr Walter Mantell, commissioner of Crown Lands, Wellington; and facing the title-page of Dr Mantell's beautiful work on "Petrifactions and their Teachings," there is an engraving of this bird, now denominated with great justice and propriety Notornis Mantelli.

The largest species of Moa—Dinornis robustus—is supposed to have stood ten feet six inches in height; but I think this is under the mark, for I saw the complete leg of a Moa put together (in a magnificent collection of bones in the possession of Sir George Grey, which were unfortunately destroyed in the conflagration of Government House in 1848), and the head of the femur or thigh bone was six feet from the ground. As the ostrich is seven feet high, and as the head of its femur is about half the height of the bird, I do not think (knowing that the legs of the ostrich are reckoned to be proportionally longer for its height than those of the Moa) I am wrong in concluding that the Moa, whose inferior extremity I saw put together, must have stood, when alive, about thirteen or fourteen feet high. The Moas were unable to fly, as their rudimentary wings were incapable of raising them from the ground, and the only bone that I have seen which I took for the humerus was sent to Professor Owen, and it was but a small one. The Moa had three toes on each foot, and some New Zealanders describe the domestic cock as being a perfect picture in miniature of that bird. The feathers of the Moa are described as having been most beautiful, which would lead us to infer that they were of various colours, for Maoris are all fond of gaudy colours; the bones of the legs of the Moa were filled with marrow, and not with air like other birds; portions of the eggs of the bird have been found among their bones, of a sufficient size to afford a chord to estimate the probable size of an entire shell, and the conclusion is, that a hat would have been a proper-sized egg-cup for a Moa's egg.

Places on New-Zealand where Moas' bones have been found.—In the middle island Moas' bones were found by Percy Earl, Esq., at a place called Waikouaiti, seventeen miles north of Otago,* in a swamp which is almost submerged under the sea, and only visible at low water. Mr Walter Mantell conceives it to have been originally a swamp or morass, in which flax (*Phormium tenax*) once grew luxuriantly. Some of the largest bones and finest specimens have been obtained from this part of the country.

In the north island, Moas' bones have been found in the beds of rivers, running from mountain regions of the interior into Hawk's and Poverty Bays; the collection of bones sent to England in 1842 by Archdeacon W. Williams, were obtained from this district, and also those described by Mr Colenso; and bones have been found by Mr Walter Mantell at the mouth of a stream called Waingongoro, which empties itself into the sea about sixty miles to the south of Taranaki. The bones were imbedded in a sand flat, were very nume-

* Mr Edward Shortland, in his work entitled the "Southern Settlements of New Zealand, 1851," gives a very good account, with a map, of the bay and river of Waikouaiti.

rous, and most of them were as soft as pipe-clay. On a bluff near the embouchure of the river, Mr Mantell saw the sand flat strewn with bones of men, moas, and other birds. They had probably been brought down the stream, and originally covered over with sand, which sand had been drifted away when he saw them. Moas' bones have also been found by Mr Mantell near the above place, in circular holes containing beds of ashes with charcoal. Moas' bones have been found by myself in two caves in the mountain limestone formation, near the western coast; and I have seen bones which were brought from other caves in this district. There is a volcanic hill called Hikerangi, near Tuhua, thirty miles from the Taupo Lake, near the top of which, I was informed, there was a cave which contained Moas' bones. Dieffenbach mentions that the Rev. Mr Taylor found bones in a rivulet near Whanganui, which flowed from a mountain called Hikerangi. I purchased bones at Rotoaire, which were found in a cave on the hill between the lake and Taupo; but as that cave was tapued in consequence of its being a place of sepulture, the natives would not conduct me to it. At Rickawa, near the south end of the Taupo Lake, the pa of the great chief Te Heuhea gave me a metatarsal bone, which he told me he had found among the scoriæ rock, on a hill near Taupo; and I have seen the femur of a Moa which was found in the sand at the mouth of the Waikato river, which river has its origin or spring in the Taupo Lake. No bones have ever been found north of Auckland.

Are all the gigantic Moas extinct?—There are a few New Zealanders who believe that some of these feathered giants still tread upon the earth; but to prevent the least charge of credulity from being brought against myself, I shall not insert any of the stories which I have heard from the natives on this subject, because they all possess more or less the air of fiction, and none of them the least appearance of fact.

There are also Europeans in New Zealand who believe that Moas are still in existence in some of the remote and unfrequented wilds of the middle island; but such stories are unsupported by any evidence of a credible nature. A European informed Mr Colenso, in 1842, that a Moa was then living in the snow-capped hills above Cloudy Bay, and that two Americans, who resided in the neighbourhood, equipped themselves with fire-arms, and proceeded in pursuit of the monster They hid themselves in a thicket near the place where he lived, and shortly after they saw him stalking about in search of food; but they were so petrified with horror at the sight, that they were unable to fire.

They observed the monster, by their own account, for near an hour ere he retired, and were right glad to escape from witnessing a meal, where instead of eating they were all but eaten. This Moa was described as being about 14 or 16 feet high.* Mr Colenso did not place the least credit in this story.

In a periodical,† of which only two numbers were published, there is a paper on the geology of New Zealand, by the Rev. Mr Taylour, in which it is stated that "he was informed by Mr Meurant, a government native interpreter, that in the latter end of 1823, he saw the flesh of the Moa in Molyneux Harbour, in the middle island, and that the flesh looked like bull-beef;" and that he also saw a Moa's bone, which reached four inches above his hip from the ground, and as thick as his knee, with the flesh and sinews upon it. The natives told him that the Moa, whose flesh he had seen, was a dead one which had been found accidentally; that they had often tried to snare them, but without success. A man, named George Pauley, now living in Foveaux Straits, told him he had seen a Moa, which he described as being an immense monster, standing twenty feet high; he said he saw it near a lake in the interior, and it ran from him, and he ran from it; that he saw its footmarks before he came to the river Tairi in the mountains. Thomas Chasseland, a man who sometimes interpreted for Meurant, and is well acquainted with the Maori language, used to say that he also had seen the flesh of the Moa, and at first he thought it was "human flesh."

If these stories were all true, there could be little doubt that a Moa of the largest breed may still be living in the solitudes of the middle island; and if so, probably some enterprising colonist, from the settlements of Nelson, Otago, or

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* Tasmanian Jour., No. vii., 1843. † New Zealand Mag., April 1850. Wellington.

Canterbury, might obtain a living Moa, and realize fame and fortune by exhibiting it in the different capitals of Europe.

It is painful to me attempt to throw discredit on any statement which has been introduced to the world by the Rev. Mr Taylour; but if exaggerated stories like these are allowed to pass uncontradicted, after being put forward in such a way, they become every year more and more hurtful, because they increase in weight as they grow in years. It is, therefore, solely for the sake of truth that I bring forward Mr Meurant's story for the purpose of stating that I do not believe it. I would not have noticed it at all if it had been confined to the New Zealand Journal; but I observe it is quoted in a book of considerable weight.* I knew Mr Meurant personally; he was an old New Zealand sealer, a peculiar race of men, now almost extinct, born in New South Wales, soon after the settlement of that colony. In early manhood Meurant abandoned the place of his birth, and adopted the adventurous life of a sealer, which he followed for many years; he was an honest, good, intelligent man, but much given, as many uneducated travellers are, to the marvellous, and many of his stories were connected with the middle island of New Zealand. I well recollect, one dark night, five years ago, when crossing the Houraki Gulf in a very bad boat, that I sat up many hours listening to Mr Meurant's curious old stories about sealers and whalers, and the changes which time had worked on New Zealand and the New Zealanders. It was shortly after the earthquake at Wellington, in 1848, that this occurred; and the conversation turned to it, and Meurant said that the earthquakes in the middle island were most fearful, and that he had seen the tops of the mountains touching each other from the violence of their shakings. I told this next morning to one of my companions, and he said, Do you not know that Meurant has a strong imagination? Now, let me be clearly understood, for Mr Meurant is since dead, and cannot defend himself. I do not say that the whole of his story about the gigantic Moa is a fiction,—*quite otherwise;* I believe there was some slight foundation for it; most probably he may

* Annals of Natural History, No. VIII. London, 1851.

have seen a large Notornis Mantelli. This bird is two feet high, and such an animal was caught alive in 1850,—which time and Meurant's fertile imagination may have magnified into one of the largest of the feathered giants. I have asked several men who knew Meurant, what they thought of his statement about the Moa, and they all said that they could not bring themselves to believe it.

For my own part, I never saw or heard of a New Zealander who had seen a large Moa, nor have I ever seen or heard an account of a large Moa having been seen, which carried the least evidence of truth on the face of it. That the gigantic Moa is extinct, I have not the smallest doubt; but it is still probable that a few more living specimens of the Notornis Mantelli may yet be found in the southern parts of the middle island of New Zealand. This statement is made with the perfect knowledge that Sir Everard Home, R.N., when commanding Her Majesty's ship "North Star," in the Pacific Ocean in 1844, stated that he felt little doubt that a Moa (Dinornis) may still be found alive in the middle island.* Since that period considerable portions of the solitudes of the middle island have been explored by Mr Thomas Brunner, and by officers of Her Majesty's surveying ship Acheron, and by colonists from different settlements in search of roads and grazing districts, but none of these have seen the least trace of a living gigantic Moa.

Is it probable that the Moa once lived on some of the Tropical Polynesian Islands?—In the Connecticut sandstones of the Permian period, in North America, the footprints of gigantic birds have been seen.† In 1850 the bones and eggs of a gigantic bird were found in Madagascar, different from the Dodo, but approaching, although differing from, the Dinornis.‡ Such discoveries suggest the question, whether it is probable that Moas may have once lived on some of the Polynesian islands scattered about in the Pacific Ocean? The bones of the bird, it is true, have never been

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* Professor Owen on the Dinornis, Part II.

† Professor Hitchcock, Trans. American Academy of Arts, 1848.

‡ See Translation of M. Geoffrey St Hilaire's Paper on some Bones and Eggs of a gigantic Bird, from the Madagascar Annals of Nat. Hist, vol. vii. 1850.

found in any of these islands, neither have the inhabitants any tradition about the animal; but the natives of the Polynesian islands apply the term Moa to the domestic fowl. Is this not a kind of proof that an animal resembling the New Zealand Moa had lived at one time in these islands; otherwise, how is it to be accounted for that the same race of men should in one set of islands call a domestic fowl a Moa, and in another island confine the term Moa to the large struthious order of birds known to naturalists as the Dinornis? This is an important point in the history of the New Zealand Moa. I shall, therefore, endeavour to explain it.

There is strong evidence, drawn from a similarity in language, customs, physical appearance, and character, that the true Polynesian race which now people the numerous islands in the Pacific and New Zealand are of Malay origin, and that originally the present inhabitants of all these islands come from Malacca and Sumatra; and on referring to the best dictionary of the Malay language,* I find the word *mūā*† is a species of pheasant; that *me mūā* means to make the voice peculiar to that bird; and *I āngān me mūā angkau dé sini* signifies "do not thou be moaning here." It is, therefore, obvious that before the Polynesians migrated from their original country, they were acquainted with a bird which they called the *Mūā*. On their arrival in their canoes at some of the Polynesian islands which they now inhabit, they probably discovered the domestic fowl of the islands in a wild state, in the woods (for this animal was found in a domestic state in all the tropical Polynesian islands, where they were first discovered by Europeans), they had to give the animal a name; and being acquainted with two words in their own language to select from, *mūā* and *mānuk*, —the first being applied to a species of pheasant in their native land, the latter being the term in the Eastern islands (through which they had probably passed) for a bird or fowl.‡ They could not properly apply the words *āyam* and *hāyam*, which are the Malay words for domestic fowl, to an animal which was running about wild in the woods; and therefore

* Dictionary of the Malayan Language, by W. Marsden, F.R.S. Lond., 1812.

† U is sounded oo, as in moon, sloop, fool. The ā, as in want, ball, call.

‡ Marsden's Dictionary of the Malayan Language.

they called this species the *Mūā*—now changed to Moa, from some resemblance which it may have had in their eyes to the Mua of their native country. In process of time the wild bird became domestic, but still it retained its original name. Things were different with the Malay branch of the human race who migrated to New Zealand. When they took possession of it there were no domestic fowls indigenous to the country; but they saw a new bird, as the ancient song says, to which they gave the term Moa, or Mua,—a name which the natives of the present generation say was given to it on account of its moaning voice. But although applicable in this way, yet the name may have been given to it from another cause. In course of time European vessels introduced the domestic fowl to the New Zealanders, but they could not apply the term Moa to it, as this name was already appropriated; so they fell back on the word manuk, the term for a bird or fowl in the Eastern islands. Manu, in the New Zealand language of the present day, is the general term for all birds, though it is likewise often applied to the domestic fowl, as a distinct name. Tikaokao is properly a name given to a cock from its crow, and heihei is a hen, a corruption probably of the English term for a female fowl.

This tedious explanation, which I have considered it necessary to enter upon for the elucidation of the history of the Moa, tends to shew the kind of proof which the language affords for advancing a knowledge of the history of the New Zealand race.

Probable time at which the New Zealanders arrived in New Zealand.—This is an important point to ascertain towards the elucidation of the history of the Moa, and it is satisfactory to find that we are not left entirely in the dark on this subject.

The New Zealanders are in the habit of keeping a numerical record of the chiefs who have lived and ruled since their arrival in New Zealand. They have sticks upon which a notch is made as each chief is gathered to his fathers; and it was the duty of the priests to keep this knowledge alive among the people, and they did so by frequently going over before the assembled tribes the names of all their dead chiefs.

I have several of these sticks in my possession (Papatupuna, as they are called), and the names of the ancestral chiefs of several tribes, written down from the mouth of well-informed people among the natives. It would therefore appear, taking the average of several tribes, that there have been between eighteen and twenty-five generations of men, since the arrival of the first settlers in New Zealand. The tribes appear all to have arrived in the country at the same time, although in different canoes; and if we allow 22 years as the average reign of each of the chiefs, this will indicate that the present race of natives arrived in New Zealand four or five hundred years ago; in other words, they arrived about the 15th century. My reason for assuming 22 years as the average duration of the reign of each of the chiefs, is calculated in this way. In England, from William the Conqueror to William the Fourth, thirty-four sovereigns reigned for 763 years, which gives $22\frac{1}{2}$ years as the average length of each reign, including those who died by violent deaths.

It is difficult to ascertain what number of generations of New Zealanders have passed away since the time when the first settlers of the present race of natives landed in New Zealand; because it appears they were often in the habit of recording the names of the brothers of the chiefs, as well as the chiefs themselves,—a practice which is apt to lead to the supposition that more generations of natives have passed away than ever did exist. There are two genealogical trees, however, which relate to the tribes Ngaiterangi and Ngatiwakaue, on which I place much reliance, because these genealogical trees were carefully investigated before the resident magistrate at Rotorua, in order to ascertain which of these tribes had a right to the island of Motiti in the Bay of Plenty; and as a test of the accuracy of the genealogical evidence, the statements of each party were carefully inquired into by the opposite party.

It requires a circumstance like this, or some historical inquiry, to excite the New Zealanders to tax their memories about their ancestors; otherwise a natural delicacy, or a fear of saying anything that may lead to mischief, makes them avoid the subject, unless specially inquired about.

Were there any gigantic Moas alive when the New Zealanders arrived in New Zealand?—I think there were not many gigantic Moas in New Zealand at that time, for, although there are traditions enough to enable us to conclude that there must have been some of them cotemporary with the first New Zealanders, yet several tribes, *e.g.*, the Ngapuhis, who live in the northern part of the north island, have no traditions about the Moa, and they have asked Europeans to describe to them what kind of an animal it was. The country where the Ngapuhis tribe live is the narrowest part of the island, and no bones of the bird have been found in this district; and if the Moas had been so numerous as to have furnished food for the inhabitants, according to Professor Owen's idea, we should have had a greater variety of traditions about them. I have heard and read several accounts of what the natives saw when they first landed in New Zealand, but in none of these traditions is there any mention made of their having seen a Moa on the sea-coast. The Dodo was abundant, according to Leguat,* near the sea-coast.

It is supposed that there were more Moas in the middle than in the north island, but I doubt this circumstance. All the bones that have been seen in the middle island have been found in a limited space, and in good preservation,—a fact which may have produced this opinion.

Probable time which has elapsed since the last gigantic Moa was seen.—A few years before the death of the great chief Tee Rauparaha, he was asked if he had ever seen a Moa himself, or a man who had seen one, and he said he had not. As he was then about 80 years of age, his answer takes us back about 160 years; and as I believe from careful inquiry that this is tolerably correct, I do think we will not be far wrong in assuming that all the Moas were extinct in this country 200 years ago, or about two centuries after the arri-

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* A New Voyage to the East Indies, by Francis Leguat and his Companions. 8vo. London, 1708.

val of the New Zealanders in the island; in other words, about the year A.D. 1650.

The Dutch navigator Tasman visited New Zealand in 1642, but none of his crew landed, or had any colloquial intercourse with the natives, so that from this visit nothing about the Moas can be gleaned; and no other European navigator, who has written an acount of his voyage, landed in New Zealand until after the Moas had become extinct. Captain Cook was told about a gigantic lizard which had lived in the country, but nothing about a gigantic bird.

Causes of extinction.—Professor Owen is of opinion that the Moas were exterminated by the New Zealanders using them as food; and he attributes their extinction in a country destitute of large animals as one of the causes which led the New Zealanders to adopt the horrid practice of cannibalism.

The first supposition is very doubtful, and the second is not probable. I admit the advent of the New Zealanders in New Zealand must have produced the destruction of a few Moas, but I cannot bring myself to believe that their extinction was entirely brought about by this cause. According to the most authentic sources, the New Zealand population, when at its greatest, never much exceeded two hundred thousand souls; and for one hundred and fifty years after their arrival in the country, they could not have increased to one hundred thousand. Now let us imagine this small population spread over a country nearly as large as England—a population fearful of trespassing on the lands of other tribes—a population of indolent people—and we will have at once a strong argument against the opinion that the Moas were cut off from the earth entirely by human agency. There are mountain ranges where the feet of men have rarely trodden. I have walked through forests for thirty miles without seeing the sign of a habitation; in such places the Moa could find ample shelter in the present day. The middle island of New Zealand offers a still stronger argument; on it the Maori population were scattered along the coasts, and were few in number; and yet, according to the best information, no large Moa has been seen on that island for upwards of one hundred and sixty years. It is only necessary to call to mind the difficulty there was in extirpating wolves from England, to have a clear idea of the improbability of the New Zealand race having caused the extinction of the Moa. In a small island a race of large birds might be easily extirpated, and we have some recent examples of this; but in New Zealand, I think, the New Zealanders arrived in time to see the last of the large Moas die.

The circumstance of Moas' bones having been found in caves of more recent appearance than those found by Mr Walter Mantell in the cooking-holes of the New Zealanders at Waingongoro, would lead us to infer that some of the Moas died in these caves after the advent of the New Zealanders. On asking a native of the cave district near Parianiwaniwa, what brought all these Moas' bones into caves, he said, that long ago an eruption of Tongariro occurred, which set fire to the country, and that the Moas fled to the caves, and there perished. This tradition, although it may be an exaggeration of some local conflagration, is of some value, as shewing there were other causes which proved destructive to the Moas in addition to human agency. At Rotomarama, near the "cave of the spirit," one of my fellow-travellers asked a well-read Christian native, what destroyed all the Moas, and in reply he said it must have been the great flood. The similarity of the words Noah and Moa may have suggested this to his mind, but my friend got the better of the argument, by asking him if it was not stated in Scripture that Noah took a pair of every living creature with him into the ark, before the flood; the man looked puzzled, and said "awa,"—an exclamation the expressiveness of which cannot be rendered into English, but means "I don't know."

There is another argument that the Moas died out, and were not extirpated by man, in the circumstance of the animals being only found in New Zealand previous to their extinction; for rarity, according to Professor Lyell, precedes the extinction of all species of plants and animals. It is apparently a law of nature, that certain races of men, plants, and animals, have a period of creation, increase, and decay. May we not then state, and with some probability we are nearly right, that the period of the extinction of the gigantic Moa occurred about the 17th century, and that this event might have been slightly hastened, but not produced, by the hand of man. New Zealand appears to have been the last refuge for wingless birds; but as sure as the race of men who peopled ancient Babylon and Nineveh, and other countries, have become extinct, and as surely as many of the Polynesian race are now decaying, so certainly will the whole of the wingless birds in New Zealand, like the Moa, become extinct. They have run their course, have fulfilled their destiny, and are now following the law which the Creator has stamped on all his works.

Professor Owen's idea that the want of food after the extinction of the Moa may have caused the New Zealanders to adopt the disgusting custom of cannibalism is not at all likely; for the motives which led the New Zealanders to eat human flesh were hatred, revenge, and to cast disgrace on the person eaten. That it was unlawful for women to eat human flesh, unless under some peculiar circumstances, will at once set at rest the supposition that human flesh was ever made a substitute for animal food. I do not make this statement without inquiry; but the subject is foreign to this paper, otherwise I would enlarge upon it.

Observations on some of the probable habits of the Moas. —I. *They were of an indolent nature, and not much given to moving about.*—This I infer, because the New Zealanders always describe them as being very fat; and Mr Owen concludes they were a more sluggish bird than the Ostrich, in consequence of the small size of the neural canal of the spine, and the relative shortness of the ankle-bone metatarsus.

II. *They lived in mountain fastnesses and secluded caves.* —This I infer, because all tradition points to such districts as the probable places where Moas' bones are still to be found. The finding of bones in caves almost confirms this idea; for if the Moas did not live in them, they resorted to them to die. The Ostrich and Emu live in plains; perhaps the habits of the Moas were somewhat similar to these birds, and they may only have resorted to hills, forests, and secluded places, after the advent of the human race. The Kiwi or Apteryx is found in forests, hills, and secluded spots, and this strange bird may have some of the habits of the Moa.

III. *They lived chiefly on vegetable food.*—This conclusion is drawn from the adze-like shape of the beak, from their bodies being described as very fat (no flesh-eating bird is ever fat), from nature having endowed them with feet and toes remarkably well adapted for uprooting fern root and other subterrestrial substances, which abound in New Zealand, and from their swallowing stones to assist in digestion. No flesh-eating animal ever does this.

IV. *They were in the habit of swallowing stones to assist digestion.*—This statement rests on tradition. The New Zealanders point out certain stones which they say have been in the stomach of a Moa. This habit is confined to vegetable-feeding birds.

V. *They were dull and stupid birds.*—This is inferred, because the skull is low and flat, and is confirmed by the traditions of the New Zealanders.

VI. *They were in the habit of standing and resting on one leg.*—My authority for this is not good, but I give it to convey some impression of what is now said by the New Zealanders about the habits of the Moas. A most intelligent Maori, who belongs to one of the interior tribes, told me that he knew where a Moa lived. I asked him where it was, and what the animal did all day. He said, it stood in a cave in which there was a waterfall, and that the bird stood first on one leg, and then on the other. All this story is fabulous, but the statement of its standing on one leg may probably have some foundation in the habits of the bird.

Deductions drawn from the Moas' bones as to the probable *length of time which has elapsed since the birds were alive.*—The best preserved Moas' bones that I have seen were those obtained from the swamp or morass at Waikouaiti, in the middle island of New Zealand. This is, however, no proof that they were more recent than those found in a less perfect state in the north island, because peats and morasses act as antiseptics, and bones have been preserved in a perfect state in such places for a great many centuries. The bones of birds are so much more delicate than those of quadrupeds, that very few of them are found in a half fossilized state. Even the bones of the Dodo, which strange animal was seen alive in considerable numbers at the Mauritius not many centuries ago, have apparently decayed away off the face of the earth. The very circumstance of Moas' bones being found in a tolerably perfect state is therefore a strong evidence of the recent existence of these birds. The natives near the cave of the Moa relate that their fathers were in the habit of taking the skulls of the Moas to keep the powder they used for tattooing, and pieces of the long bones as hooks to catch fish, in consequence of their hardness. Now, none of the bones or skulls that I saw in this cave were sufficiently perfect for such purposes, and therefore I must conclude either that all the most perfect bones had been taken away, or that the process of decay among Moas' bones was very rapid.

As perfectly fossilized bones are generally allowed to be of greater age than half fossilized ones, it is therefore obvious that some idea of the age of bones may be formed from the quantity of animal matter they contain. Let us apply this test to the Moas' bones.

I carefully examined several Moas' bones from the cave of the Moa, and found that the quantity of animal matter contained in them was very different. In the cancellated structure of the heads of the long bones of the inferior extremities, the proportion of animal matter was as low as five per cent., but in the shaft of the tibia, the ribs, and a piece of the sternum, I found it as high as ten per cent. In one cervical vertebra of a small bird, which had the outward shell perfect, the quantity of animal matter was thirty per cent.—the animal matter retaining the figure of the bone after the inorganic matter had been extracted by muriatic acid. Several of the tracheal rings were found entire, and had a remarkably recent-like appearance.

For the purpose of testing the accuracy of my analysis, I transmitted several specimens of Moas' bones to Theophilus Heale, Esq., of the Great Barrier Copper Ore Mine, and he gave me the subjoined as the composition of the cancellated head of a very decayed tibia, viz.—

Carbonic acid	4·80	decimal parts.
Animal matter	5·50	,,
Insoluble earthy matter	6·50	,,
Lime	45·66	,,
Phosphoric acid	34·50	,,
Magnesia	·70	,,
A small amount of the peroxide of iron	·00	,,
Loss	2·34	,,
	100·00	

Mr Heale found that the more solid bones contained a much greater amount of animal matter. The bone submitted to the foregoing careful analysis had a pale brown colour, was very light and porous, the outer shell was much destroyed, and the cellular structure, although perfect, contained a quantity of earthy matter.

The composition of recent Moas' bones is unknown; but as the bones of the Moas resemble the bones of quadrupeds in containing marrow, and as the bones of quadrupeds are composed of about one-third of animal, and two-thirds of earthy and alkaline salts, let us take them as a subject of comparison.

It therefore appears that some of the Moas' bones had lost a considerable quantity of their animal matter, and others very little. Now, what conclusion can be drawn from this as to their probable age?

I can find no experiments which will enable me to answer this question. In the widely-scattered bone brecciæ of the

Mediterranean, Dr John Davy * was only able to find a trace of animal matter. M. Marcel de Serres and M. Ballard, chemists in Montpellier, procured some human bones from a Gaulish sarcophagus, supposed to have been buried some fourteen or fifteen centuries at least, and they had lost three-fourths of their original animal matter.† Several skeletons of men were found in the West Indies, incrusted with a calcareous cement; but they only retained a small portion of their animal matter;‡ whereas a skull three thousand years old was taken from a tomb in ancient Thebes, and contained about half of its animal matter.§ In 1845, the fossil remains of a gigantic Mastodon were exhumed in the town of Newburgh, New York, and twenty-seven per cent. of animal matter was obtained from some of the bones ‖ (tusks and teeth), while skulls found by Mr Stephens in Yucatan were almost entirely destitute of animal matter.¶

These examples tend to shew what length of time bones, under favourable circumstances, will retain their animal matter, and that no conclusion can be drawn as to the probable age of the Moa's bones in the cave of the Moa, from the circumstance of some of them still retaining only one-seventh, and others nearly the whole of their animal matter.

General Remarks.—Is it probable that New Zealand was once connected with Australia? This is not at all likely, seeing there is so little resemblance between the flora and fauna of the countries, and neither in the ossiferous caves or tertiary deposits of the continent of Australia have Moas' bones been found.

Is it probable that New Zealand was once connected with America? This, Professor Owen thinks, may have been the case at a remote geological period; and he is inclined to regard New Zealand as one end of a mighty wave of the un-

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* Physiological and Anatomical Researches; 1839.

† Lyell's Principles of Geology.

‡ Ibid.

§ Dr John Davy.

‖ Lyell's Principles of Geology.

¶ Incidents of Travel.

stable and shifting crust of the earth, of which the opposite end, after having been submerged, has again risen with its accumulated deposits in North America, shewing in the Connecticut sandstones the footmarks of the gigantic birds which strode its surface before it sank; and to surmise that the intermediate body of the land wave along which the Dinornis may have travelled to New Zealand has progressively subsided, and now lies beneath the Pacific.*

This beautiful idea rests on Dr Deane's discovery, in 1843, of the footprints of many species of three-toed birds of gigantic size, and of the imprints of others with four toes, with the prints of twelve kinds of quadrupeds supposed to belong to the Saurian, Chelonian, and Batrachian orders, in the sandstone in Connecticut. There still lives, to give some reality to the above in the secluded parts of South America, a three-toed wingless bird; but to give weight to Professor Owen's idea, it would be requisite to discover the bones of some of these birds and quadrupeds, for we have high authority for refusing to pin our faith to impressions without the discovery of bones.

To those who believe in the doctrine of specific centres, or that every species of animals and plants on the surface of the globe originated in a single birthplace, there will be no difficulty in explaining how the Moa was confined to the New Zealand group of islands. New Zealand (they would say) was the centre of the creation of those numerous species of wingless birds we find upon it, some of which are strange to all other parts of the world. Perhaps New Zealand is only a part of a great southern continent, the remainder of which now lies at the bottom of the sea. Captain King, R.N., states there are soundings from Cape Maria Vandeman, in New Zealand, to Norfolk Island, and I have been told by old New Zealand whalers that there are soundings between New Zealand and the Chatham Islands. I cannot bring myself to believe that the gigantic Moas were ever hatched to live and die on the small spot of earth we now call New Zealand.

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* Memoirs on the Dinornis, Part II.

It is a curious circumstance, that the few islands upon which the bones of large extinct birds have been found are all situated in the southern hemisphere, and there are some points of resemblance between the islands of the Mauritius, Madagascar, and New Zealand, sufficient to excite the attention of the thoughtful and speculative. These islands are situated to the south of the line, between long. 45° and 180° east. They are chiefly of volcanic origin. The zoology of all three is peculiar. So far as that of Madagascar is known, it can scarcely be assimilated to that of Africa or Asia; while it appears equally distant from that of Australia. There is, however, too little known about Madagascar, or the large bird, the remains of which have only lately (1850) been found, to allow me to speculate on the subject. But when I turn to the two islands most celebrated for the remains of feathered giants, the Mauritius and New Zealand, I find a wonderful similarity in some things. Both are surrounded by large oceans, in the neighbourhood of large continents; both are in a genial climate in the southern hemisphere; both were discovered by Europeans much about the same time, and both have been only lately occupied by the human race. A rat* constitutes the quadruped indigenous to both islands, and in both the large birds which were observed upon them soon became extinct. Bontius, in 1658, saw the Dodo alive in the Mauritius. I infer New Zealanders saw a few Moas alive early in the seventeenth century. There is this great difference between the two places. We have written testimony of the existence of numerous Dodos in the Mauritius; but, in the present day, some men doubt whether they ever lived, because the bones of the animal cannot now be found on the island. In New Zealand, on the contrary, the existence of the Moa rests on a few

* It is doubtful whether the present rat of New Zealand is indigenous. It is very probable that it accompanied the early settlers. Similar animals are found over all the Polynesian Islands; and the United States' exploring expedition met with rats on Gardner's Island, one of the Phenix group, during their passage from the Feejee Islands to the Sandwich Islands,—a circumstance which made them assume it had been inhabited by the human race.

traditions and sayings, but the dead bones of the animal are abundant, and testify to a fact which no man can doubt.

Let us look at the living wingless birds which still live in the world. They appear to be a condemned race, for we find the signs of decay stamped on the faces of them all, and they seem to have an inborn antipathy to the human race; for wherever men appear they disappear, even without the use of destroying agencies. The Ostrich selects his residence in places where men can scarcely live, namely, under a burning sun, and on sandy deserts. The American Rhea vegetates in secluded places, and is seen with difficulty, for they can perceive the approach of men, when the eyes of men cannot observe them. The Emu is fast disappearing before the Anglo-Saxon colonization of Australia. The Apteryx selects the most secluded places to live in, and the Cassowary is very rare in the few islands where it is known to be indigenous.

It would seem that this strange species of animals—birds without wings!—were created to live in solitary places far away from the haunts of men. They may have been created at a period long prior to that of the higher order of quadrupeds, for we see the marks of their feet in sandstones of an early date.

New Zealand appears, according to the testimony of the natives, in former days to have abounded in Saurian reptiles of immense size. There were no land Mammalia on the islands,* but many birds, ferns, and fern-like plants. Some growing to the height of sixty feet are found covering a great part of the north island, and the largest and most abundant timber-trees, belonging to the Coniferæ, are here in great plenty, and earthquakes are not unfrequent.

AUCKLAND, NEW ZEALAND, *July* 12, 1853.

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* The dog, rat, and bat, are perhaps introduced.

Norway and its Glaciers visited in 1851; *followed by Journals of Excursions in the High Alps of Dauphine, Berne, and Savoy.* By JAMES D. FORBES, D.C.L., F.R.S., Sec. R.S. Ed., Corresponding Member of the Institute of France, and of other Academies; and Professor of Natural Philosophy in the University of Edinburgh,

(Continued from page 169.)

§ 2. *On some Peculiarities of the Climate of Norway.*—The time can hardly be said to be gone by when an erroneous belief was prevalent as to the utterly inhospitable climate of Norway. Bishop Pontopiddan cites the amusing mistake of our English Bishop Patrick, who describes a Norwegian as imagining a rosebush to be a *tree on fire*; whereas roses are common flowers in many parts of Norway. He farther adds, that the harbour of Bergen is not oftener frozen than the Seine at Paris, that is, two or three times in a century, whilst the harbours of Copenhagen and Lubeck are frequently blockaded with ice. This he justly ascribes to the influence of the open sea. A still more singular fact is, that the smallest piece of drift ice is unknown on any part of the Norwegian coast, though it extends to lat. 71°, while off the coast of North America, they are occasionally seen in lat. 41°* Until a comparatively recent period, it was generally believed that the temperature of the North Pole was 32°, of the equator about 86°, on an average of the year, and that every place had an intermediate temperature depending solely on its latitude. The influence of sea or land in great masses in altering the climate—the former as a general moderator of extreme heat and cold, the latter in increasing the inequalities of climate—was next perceived, and the inflections (as they are called) of the isothermal lines, were clearly indicated by Von Humboldt. The isothermal lines are lines which pass through all points of the earth's surface in each hemisphere which possess the same average temperature. If the temperature depended solely on the latitude, they would form accurate

* See the limit of drift ice indicated in the vignette map, accompanying the General Map of Norway in this volume.

parallels of latitude. But as the continents are hotter than the ocean between the tropics, and colder in higher latitudes, the lines of temperature have a descending loop over the Atlantic and Pacific Oceans in the former circumstance, and an ascending one in the latter.* Thus, for example, the isothermal line of 40° Fahr., which passes nearly over Throndhjem in Norway (lat. 63°), and attains perhaps the 66th degree of latitude over the Atlantic, falls to the 48th degree in Canada (a little north of Quebec), and to the 50th or lower in the eastern parts of Asia, but rises again under the influence of the Pacific Ocean to about 60° of latitude on the western coast of North America.

A farther step in these important and curious generalizations (which are due primarily to Von Humboldt) consists in distinguishing the *summer* and the *winter* curves of temperature, which have an important bearing on the existence of perpetual snow and glaciers. Places with the same *average* temperature may be yet, the one temperate and wholesome, the other nearly uninhabitable from extreme cold during winter, which is compensated by the almost tropical heat of the summer months. Thus whilst at Throndhjem the difference of temperature of January and July is 40° Fahr., at Jakutzk, in Siberia, which is nearly on the same latitude, this difference amounts to 114°; and mercury is sometimes frozen for three months of the year. In the Faroe Islands, on the other hand, the climate of which is perfectly insular, the variation between January and July is only about 18°.

Whilst then, Norway enjoys the *average* climate superior to any other continental country in the same latitude, it is also, on the whole, less visited by extremes of summer heat and winter cold. No doubt, the different portions of the country vary distinctly in this respect, the coast possessing the moderate or insular character, the interior or Swedish side a much severer one; still, on the whole, the statement is true. It is vividly represented by the isothermal lines for January and for July, drawn by Professor Dove of Berlin, and

* See the map of Isothermal lines in Berghaus' and Johnston's Physical Atlas, or in the neat and cheap maps published by the National Society.

copied in the small chart which occupies one corner of the map accompanying this work; which at the same time shews the general position of Norway relatively to other countries, where it is observable that the northmost portion extends as near the Pole as the centre of Greenland. The blue curves which pass through places believed to have the same mean temperature of the month of January, shew that we must penetrate farther towards the Pole, in the neighbourhood of the Norwegian coast, in order to obtain a given degree of winter's cold than in any other part of the northern hemisphere. In fact, we may conceive the Atlantic as moderating the effect of winter by pouring in a flood of heat towards the arctic seas, through the enormous strait between Greenland and Norway, which connects the Atlantic Ocean with the proper "Polar Basin," if such exist, and this flood of heat spends itself chiefly or entirely on the Norwegian side of the opening —the January isothermals falling with extreme rapidity into lower latitudes on the inhospitable coast of Greenland. Now this general expression of the phenomena evidenced by the isothermal lines, has, as is well known, a physical cause precisely corresponding to it, and sufficiently explaining it. This is the continual direction of a current of the Atlantic waters, having the high temperature due to southern latitudes precisely in the line in which the arctic cold is thus powerfully repelled. The "Gulf Stream," taking its rise in the Gulf of Florida, proceeds northwards and eastwards, until it breaks on the shores of Europe and Northern Africa, a portion of it striking the western coasts of the British Isles, and being prolonged to the coast of Norway, imparting warmth to water and to land, and effectually repelling the invasion of floating ice, with which Finmarken would otherwise be continually menaced.* It has been calculated that the heat thrown into the Atlantic Ocean by the Gulf Stream in a winter's day would suffice to raise the temperature of the part of the atmosphere which rests upon France and Great Britain from the freezing point to summer's heat.

* Il faut s'eloigner de 20 à 30 lieues marines des derniers promontoires (North Cape) avant d'apercevoir des ilôts de glace ; encore sont-ils bien loin à l'horizon.—Von Buch, Annales de Chimie et de Physique, vol. ii., 1816.

The fact of such a transference of the heated waters of the tropics into Northern Europe is popularly but convincingly proved by the common occurrence of finding West Indian seeds and woods upon the west coasts of Ireland, Scotland, and Norway. Captain Sabine relates that in the year 1823 some casks of palm oil were thrown ashore at Hammerfest (lat. 71°), which were traced to the wreck of a vessel the year before at Cape Lopez in Africa.* The general direction of the Gulf Stream (only its feebler and reflected part, however) on the coast of Norway is indicated on the little chart before referred to, whilst on the west of the Atlantic a reverse stream marked, "Polar Current" is shewn descending from Spitzbergen and the "Polar Basin," between the coasts of Iceland and Greenland, charged with icebergs, and of course approaching the temperature of freezing salt water. This mass of water spends its cold on America, as the Gulf Stream does its heat on Europe, and finally sinks under the warm current off the coasts of the United States.

The position of the red curves which pass through places which have the July temperature alike, is altogether different from that of the winter curves; indeed in part of Norway (as also in Great Britain) they are very nearly at right angles. The summit of the July curves is found in Siberia, where the summer heat is overwhelming, which is moderated as we approach the shores of the ocean. *It is by the amount of the summer heat that the limits of perpetual snow are mainly determined.* The part of Norway beyond the arctic circle is of course exposed to the continued action of the sun, day and night, during part of summer; hence the rapidity of vegetation, and the intense heat which in some places prevails for a short time,—the thermometer as we have seen, rising to 84° at Alten in lat 70°.

The two sides of the Scandinavian peninsula differ exceedingly in climate, the eastern part tending to the continental, the western to the oceanic climate. The contrast between Bergen and Christiania in this respect has been stated in a former chapter. The table-land of Norway forms in all its

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* Note to Cosmos.

extent a most important barrier, which commonly separates the most opposite states of weather. The rain at Bergen is several times as great as that at Christiania. It falls chiefly in winter—that of Christiania in summer. When it rains or snows east of the Fille-field, it is most probably fine on the west. A sort of intermediate climate occurs on the western depression of the continent, but at some distance from the coast, and offers an interesting peculiarity; it is the climate of the interior of the fiords, as on the Hardanger and Sogne near Bergen, the Throndhjem-fiord above that town, and Kaafiord, as contrasted with the climate of Hammerfest. In all these cases the climate improves as we recede from the shores, the corn ripens better, the mean temperature is higher, and, at least in the far north, vegetation is more luxuriant. This arises mainly from the excessive amount of rain, fog, and cloud, which lowers out of all proportion the temperature of summer in the immediate neighbourhood of the coast. Bergen is universally known as one of the most rainy spots in Europe, and its position manifestly resembles that of Westmoreland, of Penzance, and of Coimbra, which enjoy an unenviable pre-eminence in this respect. The average fall of rain at Bergen exceeds 77 inches, while that at Upsala, on the continental side of Scandinavia in the same parallel, is only sixteen inches. At Bergen 21 per cent of the annual fall is in the three summer months, whilst at Upsala it amounts to 33 per cent.* At Ullensvang, on an interior branch of the Hardanger-fiord, though plunged in the midst of lofty mountains, the climate has already greatly improved. At the head of the Sogne-fiord it is still better. The barley was ready there for the sickle, when it was hopelessly green near Bergen. In Finmarken, again, the interior fiords, and the valleys connected with them, surpass incomparably in climate the islands and outlying portions of the coast. The valleys of Bardu and Lyngen are the most northern corn-lands in the world, and at Alten the Scotch fir attains a height of 780 English feet above the sea, and the birch of 1500 feet. At Hammerfest, which is an island

* Schouw, Climat d'Italie, pp. 170, 171.

exposed to the sea, and less than one degree of latitude farther north, nature seems almost torpid, the fogs are continual, the birch-trees are mere bushes at the level of the sea, and scarcely anything can be reared in the gardens. In short, we have the climate of Iceland, neither excessive heat nor cold, but a benumbing mediocrity of temperature and a perpetual cloud.

§ 3. *On the Position of the Snow Line in Norway.*—The occurrence of perpetual snow at a certain height above the sea in even the warmest regions in the globe, has in all ages excited the curiosity of geographers and naturalists.—Regarded at first as a very simple indication of the depression of temperature as we ascend in the atmosphere, it has been carefully studied and applied (often erroneously) to the determination of climate. Closer examination has shewn that the presence of perennial snow,—in other words, a predominance of all the causes tending to its accumulation over those which tend to its waste of fusion—is, indeed, a very complicated fact, and cannot be taken as the simple expression of any one of the elements of climate. The snow line is far from having invariably a mean temperature of 32°, as was at one time supposed. Under the equator it is about 35°; in the Alps and Pyrenees about 25°; and in latitude 68° in Norway it is (according to Von Buch) only 21°; yet, though there are regions both in the extremity of Siberia and in arctic America, of which the mean temperature is below zero of Fahrenheit (as, for example, Melville Island), it is quite established, on the concurrent authority of those best aquainted with these regions, that *nowhere in the Northern Hemisphere* does *the snow line attain the level of the sea.* The explanation is to be sought principally in the intensity of the summer heat during the period of perpetual day, which effectually thaws the soil, though only to a trifling depth, and raises upon its surface a certain amount of brief vegetation suitable for the support of arctic animals.

Another cause affecting exceedingly the level of the snow line is the amount of snow which falls. The interior of continents being far drier than the coasts, the snow to be melted is a comparatively slight covering. The snow line on the *north* side of the Himalaya is at least 3000 feet higher than towards the burning plains of Hindostan. This is chiefly due to the excessive dryness of the climate of Thibet. In like manner, five times less rain falls on the coast of the Baltic than at Bergen. All this confirms the excellent generalization of Von Buch, that *it is the temperature of the summer months which determines the plane of perpetual snow.* It is thus easy to understand why the mean temperature of the snow line diminishes towards the pole, because for a given mean temperature of the whole year the summer is far hotter in proportion. Also, places at which the temperature of the summer is low, are those which have a moderated or coast climate; but there also the fall of rain and snow is most abundant, whilst in excessive or continental climates the precipitations are comparatively small. The red lines on the small chart which indicate the mean temperature of July, have therefore a peculiar significance as respects perpetual snow; to take only one instance at present, they explain why in Iceland snow lies all the year at a height of only 3100 feet, whilst in Norway, on the same parallel, the snow line would approach 4000.

The same general principle holds good in the Southern Hemisphere. Its temperature, on the whole, being greatly inferior to that of the north (though the extremes are less), it acts towards the rest of the globe in some measure as the refrigeratory of a great distilling apparatus (as some one has correctly observed), and its higher latitudes are the seat of almost continual storms and fog, of which the climate of Cape Horn is a familiar example. Summer there can hardly be said to exist, and the snow line is proportionally low. According to Sir James Ross,* the first living authority on the subject, the snow line *does* reach the level of the sea in the antarctic regions, at a latitude between 67° and 71°, under which forests still grow in Norway, and even corn in some sheltered places.

The following are the only estimates I have met with of the level of perpetual snow in Norway, although it is probable that others exist. We shall commence with the south-west district.

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* From a private letter with which he kindly favoured me.

1. The Folgefond, on the south-west of the Hardanger country, is the most important of that region. An outlying hill (latitude 59°·9) above Rosendal, called Melderskin, is covered with perpetual snow (according to Hertzberg), though its height is only 4558 Rhenish, or about 4700 English feet. We may suppose the snow line to be at least 200 feet lower, as the summit is isolated, say 4500.

2. Lat. 60°·1. On the western or seaward side of the Folgefond, near Moranger-fiord, by my observation, the snow begins at 3800 or 3900 English feet.*

3. Lat. 60°·1. The landward or eastward side of the Folgefond ceases to be covered with snow according to the same authorities, at 1697 metres, or about 5240 English feet.

4. This last elevation has been also determined by Naumann (*Travels*, i. 130), but with a very different result. The mean of two observations of 4100 and 3950 Rhenish feet corresponds to 4150 English feet.

All the preceding determinations are subject to some doubt. In the first the *snow line* is not directly measured at all, only the summit of the hill. In the second, the barometer was acting imperfectly. The third is unquestionably much too high from a comparison with the determined height of various parts of the "fond" (see *Gœa Norvegica*, p. 159), certainly many hundred feet above the snow line. The fourth, on the other hand, is as certainly somewhat too low, the observation having been taken (Naumann, i. 109) at an outfall or depression of the glacier. It seems to me very probable that a mean of the whole will be tolerably correct, which gives nearly 4400 English feet.

5. Lat. 60°·2. Hartougen, in the Hardanger-field (Smith), 5000 Rh. ft. = 5150 Eng.—Lat. 61°. The interior range of the Fille-field (Von Buch), 1694 metres, about 5560 English feet. Mean 5400 Eng. feet.

6. Lat. 61°·5. Outlying portion of Justedals Bræen towards the sea, between Jolster and Indvigs-fiord, according to Naumann, about 4000 Rhenish, or 4120 English feet.

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* This observation though subject to some doubt, is well confirmed by the limit of the birch, as ascertained by Professor Christian Smith of Norway.

7. Lat. 61°·6. Justedals Bræen, east side, near Lodalskaabe (Von Buch and Bohr), mean 5460 English feet.

8. Lat. 61°·6. Storhougen, between Lyster and Justedal (Keilhau), 5000 French, or 5330 English feet.

9. Lat. 61°·6. In the centre of the chain, near Otta-vand (Broch), 4610 Rhenish, or 4750 English feet.

10. Lat. 62°·2. Dovre-field, according to Naumann, 5200 Rhenish, or 5360 English feet. Dovre-field, guessed by Von Buch at 1582 metres, or 5109 English feet.

11. Lat. 67°·1. Sulitelma, on the frontier of Norway, and Swedish Lapland. Wahlenberg is the sole authority. As reported by Von Buch, the snow line is at 1169 metres, or 3840 English feet; but there seems to be some mistake, for in Wahlenberg's *Flora Lapponica,* it is expressly said (Introd., p. xl.), that the summit of the mountain is 5796 French feet above the sea, and 2600 above the snow line, leaving, therefore, almost 3200 French feet for the height of the latter. Von Buch's 1169 metres* is equivalent to 3600 French feet. Wahlenberg, in another place, assigns 3300 French feet as the general height of the snow line in Lapland (p. xxxv.) M. Durocher gives 1169 metres as the height (always on Wahlenberg's authority) in the *Expedition du Nord,* and 1010 metres = 3109 French feet, in his paper in the *Annales des Mines* (1847, vol. xii., p. 79), which corresponds with none of the others. Under these circumstances, we must take Wahlenberg's own authority, and conclude that the level of the snow line at Sulitelma is probably—

On the west, or Norway side, 3200 French = 3410 English feet.
On the east, or Lapland side, 3300 French = 3520 English feet.

12. Lat. 70°. At Alten in Finmarken, which is somewhat removed from the immediate influence of the sea, the snow line is fixed by Von Buch at 1060 metres, or 3480 feet. But this being an insulated summit (Storvands-field), is hardly

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* See his Memoir on the Snow line in Norway, in the *Annales de Chemie,* already cited. It is an abstract of a larger essay to be found in the French translation by Eyries of his Journey in Norway, and in Gilbert's Annals for 1812. See also Thomson's Annals of Philosophy, vol. iii., for a translation.

comparable to Sulitelma, the greatest concentration of snowy mountains in the north of Scandinavia, and consequently colder in proportion.

13. Lat. 70°·4. On the island of Seiland, level of perpetual snow, according to Keilhau, 2880 Rhenish, or 2970 English feet; according to Durocher, 886 metres, or 2910 English feet—a close agreement.

We are at first surprised to find so few and little accordant determinations of the level of the snow line in Norway, but it is easily explained. In Norway (unlike Switzerland) the snowy regions are commonly remote from inhabited valleys; they are of difficult access, and are rarely and casually visited by the curious traveller. The ascertainment of permanent from occasional snow, always difficult, is nearly impracticable except by continued and close observation, and it is not to be expected that the natives should be able to give satisfactory information on a subject of so little interest to them.

The substance of the preceding observations may be reduced to this—

First, The first four and the sixth observations tell us that in lat. 60° to 62° the snow line at a short distance from the coast may be considered to be at 4300 English feet, or thereabouts.

Secondly, In the same latitude, towards the centre of the country, it rises (by the 5th, 7th, 8th, 9th, and 10th observations) to 5300 feet.

Thirdly, In lat. 67°, *in the interior*, it has fallen to 3500 feet, and is not much lower on *insulated* summits in lat. 70°, though on the coast it falls to 2900. This trifling effect of latitude is partly explained by the marked tendency of the summer isothermal lines to run parallel to the peninsula of Scandinavia.

Von Buch has remarked, that in Norway and Lapland the planes of vegetation of the pine and birch run nearly parallel to the plane of perpetual snow—the intervals, as observed by him at Alten, being given by the following table of limiting heights of vegetation above the sea :—

VEGETATION IN LATITUDE 70°.

The Pine (*Pinus sylvestris*) ceases at . .	237 metres =	780 Eng. ft.
The Birch (*Betula alba*) ceases at . . .	482 metres =	1580 Eng. ft.
Bilberry (*Vaccinium Myrtillus*) ceases at .	620 metres =	2030 Eng. ft.
Mountain Willow (*Salix Myrsinites*) ceases at .	656 metres =	2150 Eng. ft.
Dwarf Birch (*Betula nana*) ceases at . .	836 metres =	2740 Eng. ft.
The Snow line	1060 metres =	3480 Eng. ft.

From the growth of the birch he has estimated the level of the snow line in the islands of Qualoe and Mageroe, though neither of these rise to the requisite limit. It is probable, however, that the direct sea blast to which those bare rocks are exposed must act chemically upon vegetation in a way which would render the deduction of the snow line considerably doubtful—which doubt is confirmed by the more recent determination of the snow line on the island of Seiland, opposite to Qualoe. Still, as a guide to fill up the gaps of direct observation, I add some determinations of the limit-level of the common birch in Norway, chiefly taken from the *Gæa Norvegica*, from *Naumann's Travels*, and from the observations of Wahlenberg, and of Smith the Norwegian botanist. These are important, as indicating the *law* of the phenomenon. Von Buch estimates the interval between the limit of the birch and perpetual snow at about 1870 English feet throughout Norway; Wahlenberg, at 1960 English feet; which probably represents best the results in higher latitudes. In the following table, I have inferred the height of the snow line from the limit of the birch, by adding 1900 feet to the latter number; and I have added in another column the direct determinations of the snow level previously given.

Places where the Superior Limit of the Birch has been observed.	Mean Limit of Birch in English ft.	Snow Line in English ft.	
		Inferred.	Observed.
Lat. 59½°. Gousta-field, Tellemarken (*inland*) 3500, 3290 Rhenish feet	3550	5450	
Lat. 59½°. Suledals-field, 3090, 2760 Rh. ft. (*coast*)	3010	4910	
Lat. 60°-61°. Hardanger-field, 3320, 3440 Rh. ft., Fille-field, 3300, 3630 Rh. ft. (*inland*)	3520	5420	5400
Lat. 60°. Hardanger-fiord, Ullensvang 2900 Rh. ft., Folgefond, 1900, 2100, Voss, 2630 (*coast*)	2450	4350	4370
Lat. 62°. Lom, central chain, 3150 Rh. ft.; Dovre, 3370, 3350, 3600, 3220; Roraas, 3400; mean 3350 (*inland*)	3450	5350	5300
Lat. 64°. North Throndhjems Amt, seven observations, of which the highest is 2130 Rh. ft. on the Swedish frontier; the lowest 1790 Rh. ft. on the Börge-field; mean 2000 almost exactly	2060	4110 *inland.* 3810 *coast.*	
Lat. 67°. Gilleskaal, Salten, near the sea, and also near great Icefields of Fondal, 1200 Rh. ft.; Stegen, 1320 (*coast*)	1300	3200	
Lat. 67°. Sulitelma, W. side 1100, E. side 2100 Fr. ft. (*inland*)	1710	3610	3460
Lat. 68°. Lofodden 1510,* 1070, 1030 Rh. ft.; mean (*coast*)	1200	3100	
Lat. 69½°. Alten, Finmarken, and *interior* generally, 1550, 1550, 1300, 1420, 1150; Kaafiord, 1530; mean 1420	1460	3360	3480
Lat. 70°·6. Qualoe, 227 metres (Seiland, snow line) (*coast*).	750	2650	2940
Lat. 71°·2. Mageroe, North Cape, 130 metres	430†		

By means of a graphical construction, derived from the preceding table, I have succeeded better than I could have expected, in representing the variation of the snow line, and the limit of the birch in Norway, in terms of the latitude. But it is *absolutely necessary*, on the roughest estimate, to distinguish the Coast climate from the Inland climate. It appears, on the slightest examination, that the limit both of the birch and of perpetual snow rises as we recede from the coast towards the interior, the amount, however, varying between one latitude and another. By Coast, be it observed, I do not mean the actual shore exposed to the blast and spray of the open ocean, but generally (with some exceptions, how-

* Lödingen, sheltered exposure, Von Buch.

† From excessive exposure not comparable to the others. The same remark applies in some degree to the preceding observations at Qualoe.

ever, as at Kaa-fiord, which has a continental climate), the comparatively narrow space where the mountains have a decided western declivity. The result of the projection (due regard being had to the number and worth of the observations upon which it is based) is, that the curves are nearly flat between 59° and 62°, where they begin to decline rather rapidly—passing from convex to concave about the 65th degree, from which point northwards they decline, but with extreme slowness. This form of the snow line is, I am persuaded, in the main correct. The rapid fall north of the Dovre-field, its flatness in the south, and its slow declivity in the north, all correspond to observation. I shall now give a table founded on these curves, for every two degrees of latitude.

TABLE OF THE HEIGHT OF THE SNOW LINE AND LIMIT OF THE COMMON BIRCH (*Betula alba*) IN NORWAY.

Latitude North.	Snow Line.			Limit of Birch.		
	Interior.	Coast.	Difference.	Interior.	Coast.	Difference.
	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.
60°	5500	4450	1050	3600	2650	950
62°	5200	4150	1050	3350	2450	900
64°	4200	3650	550	2300	1900	400
66°	3700	3250	450	1750	1450	300
68°	3450	3000	450	1500	1150	350
70°	3350	2900	450	1350	950	400

It will be understood that these numbers must be considered as mere approximations. Errors of from 100 to 200 feet may well occur in the best determinations of this kind. Besides, the distinction of Interior and Coast evidently does not admit of precision.

Beyond the limits of Norway the depression of the snow line is probably much more rapid. Over the ocean we come into wholly new climatic conditions. The level of the snow line at Cherry or Beeren Island, lat. 74½°, has been estimated at 180 metres, about 600 English feet, and at Spitzbergen, lat. 79½°, at 0 ; but I have already stated that this last result is inadmissible.

The preceding discussions establish completely the influence of climate in determining the rise of the snow plane towards the interior. This is most conspicuous about lat. 60° to 62°, where the difference, it would appear, amounts to perhaps 1000 feet; but rapidly declines in lat. 64°, corresponding, in fact, to the peculiar change in the form of the peninsula (referred to at page 190), which there rapidly loses its massive and elevated character, and the climate becomes in consequence more maritime. The rise of the snow line may even be traced on the east and west side of the outlying mountains near the coast. It depends partly on the same cause as the rise of the snow line in the interior of Asia—the comparative dryness of the climate—but in great measure also on the greater effect towards the interior of the solar rays, which at Bergen, and on the coast generally, are so often obscured by clouds and fog. Wahlenberg long ago remarked the superior importance of the heat of the sun in melting snow, compared to the effect of rain.* This is also true in Switzerland, though exceptions are sometimes striking.† But in Norway, the rain which falls on summer snow can have no great warmth, nor be in any great quantity. We shall probably much exaggerate its effect, if we suppose that one-fourth of the yearly fall on the snow fields is in the state of rain, and that the mean temperature of that rain is 40° F. This quantity would thaw no more than *one-fiftieth* of the snow fallen at other seasons.‡

We observe in passing, as the result of the comparison of the configuration of the country with the position of the snow line, that though the surface actually covered by perpetual snow in Norway be small, yet the mountainous districts and table-lands everywhere approach it so nearly, that the snow

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* "Calore solis nix melius solvitur quam pluviis omnibus calidis;" and more to the same purpose.—*Flora Lapponica*, Introd., lvi.

† The floods of September 1852 at Chamouni were caused mainly by a deluge of warm rain, which acted simultaneously on the glaciers and snows up even to the summit of Mont Blanc, which was seen all the while from Chamouni, whereas falling snow always conceals it more or less. My guide Auguste Balmat mentioned these facts to me in a recent letter.

‡ M. Durocher has computed, from the observations made at the convent of the Great St Bernard in Switzerland, which is but little below the snow line, that not more than *one-ninetieth* of the annual snow is dissolved by the rain.

plane may be said to *hover* over the peninsula, and any cause which should lower it even a little would plunge a great part of the country under a mantle of frost. Nay, so nice is the adjustment, that even the convexity of the rocky contour has its counterpart in the fall of the snow line near the coast, and in the general depression towards the north. The incidence of this remark will presently be more fully perceived.

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*Notice of the "Silurian System of Central Bohemia, by Joachim Barrande."** Communicated by JAMES NICOL, F.R.S.E., Regius Professor of Natural History, University of Aberdeen.

Some time ago the introductory portions of this volume were noticed by us in the Edinburgh New Philosophical Journal, vol. l. (January 1851), p. 107, from a copy kindly forwarded by the author. In this notice an account was given of some of the more important geological results at which M. Barrande had arrived by his long and laborious researches. Referring the reader to this article, we now proceed to the more immediate subject of this volume, which contains a highly interesting account of his investigations into the structure of those singular crustaceans—the Trilobites—which form a large portion of the ancient fauna of Bohemia, and also of many districts of our own country. To shew the extent of these researches we may mention that they occupy more than 800 quarto pages, and are illustrated by above fifty plates, full of very beautifully executed figures. In collecting the materials for this curious history, M. Barrande was assisted by numerous workmen, trained under his own eye, to seek out and bring together the shattered fragments of organic beings buried in these old strata. He pays a well-merited compliment to the zeal, skill, and intelligence of the humble Bohemian peasants employed in this minute and laborious research, who, he says, have improvised a nomen-

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* Systême Silurien du Centre de la Bohême, par Joachim Barrande. Vol. i., with vol. of plates. Prague and Paris.

clature in their own language, both for the animals and the rocks in which they are found. Some of them who have been longest in his employment are not only able to catch the most evanescent traces of the minutest embryos with the microscope, but at once recognise any new or rare form in the district where they are engaged.

M. Barrande has thus been enabled to extend his researches over a far wider range of localities, and to bring together a greater number and variety of specimens than would have been possible for an isolated individual. Some of the results of this wholesale mode of collecting specimens are not only curious, but of importance in the history of the animals. Thus the Dalmanites socialis is one of the most common trilobites in Bohemia. It is characteristic of the quartzites of his stage D., some beds in the Drabow mountains being quite full of fragments of it, which form often nearly the entire surface of the rock. Yet they were only fragments; and it was some years before perfect specimens of the whole animal were found in another locality. But these were badly preserved, and though collected in hundreds did not give the information on the structure of the animal that was wanted. At length a new depository of them was discovered in the Drabow mountains, with perfect, well-preserved specimens. In these, however, the body was always extended, and a new locality had to be discovered before any were found rolled up, as was the case with all of them it furnished. Eight years had been spent in these researches, and some thousand specimens of this Dalmanites had passed through his hands, but all of adult individuals, when a new locality enabled him to complete the history, and to trace out the singular metamorphoses it undergoes, as represented in the highly interesting series of figures in his twenty-sixth plate.

Ten years' researches were thus required to work out the history of this single trilobite, and the same was true of many others. A second result of this persevering diligence was the great increase in new species which it often produced. A quarry was sometimes wrought for several years without adding a new form to his list, when all at once some novel species would reward his toil. As a stimulus to geologists in other little explored regions, we may mention, that whilst Bohemia, previous to his time (1840), had only furnished twenty-two species of palæozoic fossils to science, he has now raised the number to 1200 species, most of them fully represented by numerous fine specimens.

The very high value of M. Barrande's researches, both in a zoological and geological point of view, will perhaps be best indicated by a brief notice of some of their results. He commences with a general account of the component elements of the body of the trilobites. In this he notices the broad and long forms which the various individuals of each species present, and which seem to correspond to the two sexes,—the males represented by the long, the females by the broad specimens. He also confirms Mr Salter's observations, that the former are besides indicated by more prominent eyes, and by numerous points, spines, or other ornaments on their shell, similar to what is well known to occur in insects at the present time. He then notices each of the three segments of the body—the head, thorax, and pygidium or tail—in succession. On the head, he describes its general contour, the form of the glabella or median lobe, and of the furrows by which it is bounded. The sutures or joints by which the cephalic carapace is divided into several distinct pieces, are fully explained, and illustrated by figures of those observed in the forty-five genera he has studied. These joints have not been noticed in the recent crustacea, and were probably, as Burmeister thinks, intended to facilitate a slight motion in the pieces when the animal rolled itself up.

The eyes of the trilobites have always been regarded with much interest. He has found these organs in many species formerly supposed to be destitute of them; but a few genera, as Agnostus, Ampyx, Dindymene, and Dionide, shew no trace of eyes; whilst in Conocephalites and Trinucleus some species possess and others want them. Singularly enough, all these genera belong to the lower Silurian rocks; whereas only one species (of Ampyx) destitute of eyes has been hitherto observed in the upper Silurian stages. In one species, the Trinucleus Bucklandi, the eyes seen in the young specimens disappear in the old, as is the case in existing nature, in some sessile or parasitic crustaceans. In the structure of the eyes M. Barrande notices two types,—the first in Phacops and Dalmanites, which have the cornea opaque, like the other parts of the cephalic envelope, and penetrated by minute holes placed in quincunx, through which the lenses project; the second, found in all the other genera, has a cornea different from the common integument, and either smooth on the surface or tuberculated over the individual lenses of the compound eye. The number of these lenses varies in the same species, increasing with age. It is still more variable in different species, as the following very interesting table will shew:—

Species.	Lenses in eye.	Species.	Lenses in eye.
Phacops Volborthi, *Barr.*	14	Aeglina rediviva, *Barr.*	750
P. cephalotes, *Corda.*	200	Bronteus Brongniarti, *Barr.* ...	1000
Proetus sculptus, *Barr.*	350	B. palifer, *Beyr.*	4000
Dalmanites Phillipsi, *Barr.* ...	150	Asaphus nobilis, *Barr.*	12,000
D. Hausmanni, *Brong*...	600	Remopleurides radians, *Barr*....	15,000

In the genus Harpes alone, simple eyes, like the stemmata or ocelli of the recent articulata, appear, and only two or three in number. Both these and the diverse forms of the compound eyes are represented in Plate 3. From this it would appear that the individual lenses are generally round or hexagonal in form, and never quadrangular, as in some modern crustacea. This fact, and the smoothness of the cornea, would seem to indicate that the eyes of the trilobites were rather an agglomeration of simple eyes than truly compound eyes, like those of the higher crustacea now living.

M. Barrande next describes the other portions of the head, the cheeks, with the hypostome and epistome, pointing out the value of the characters which the forms of these parts furnish to the palæontologist. We, however, pass on to the thorax, and to his account of the various segments of which it consists. As is well known, the number of these was at one time thought constant in each species or genera, and this principle was applied to their classification and determination. The analogy of existing nature might have taught us that this would probably be true only of full-grown individuals;

and M. Barrande's observations, as we shall soon see, fully confirm this view. It, however, appears, that in the adult trilobites the number of segments in every part of the body is constant for each species. Emmerich's law of the constancy of the number of segments furnished with pleuræ (20), on the other hand, is not established. So also the supposed law that the number of segments in the thorax of each genus was constant, has not stood the test of M. Barrande's wide experience, though, singularly, no exceptions have yet been observed in the genus Phacops, from which it was first deduced. Still less have his observations confirmed the supposed law of the constancy of the number of segments in the whole body of each genus or family of trilobites, the abdomen gaining in number as the thorax lost, and the reverse. As general results, M. Barrande finds the number of segments varying—in the head, from species in which no segmentation appears, to 6 segments in Paradoxus spinosus and others—in the thorax, from 2 in Agnostus to 26 in Harpes ungula; in the Pygidium, from 2 in Sao hirsuta, and many others, to 28 in Amphion multisegmentatus; and in the whole body from 11 to 38, or in the last-named species perhaps to 52. In the same genus the number of segments in the whole body range from 24 in Dalmanites solitaria to 38 in D. auriculata.

The power of rolling themselves up was long considered as highly characteristic of certain trilobites, and even made the basis of some systems of classification. M. Barrande gives many highly interesting observations on this faculty, for which we must refer to his work. Of the forty-five species he studied, twenty-seven have been ascertained to roll themselves up,—in eighteen it has not been ascertained; but, except Ellipsocephalus, Ogygia, and Paradoxides, only few and fragmentary specimens have as yet been found of these species. On the whole M. Barrande concludes that this power was common to the tribe, and therefore not characteristic of particular genera or species.

M. Barrande next notices the forms and characters of the pygidium, but we pass on to the section in which he treats of "the feet and organs of the trilobites." In regard to the former, his observations only confirm the fact that these organs either did not exist, or were of such a soft and perishable nature as to leave no recognisable impression on the rock. Adouin and Burmeister both came to this conclusion, from considerations drawn from other features in their organization, and none of the instances of the supposed discovery of feet have borne the test of strict investigation. It is different with the intestinal canal of the Trinucleus, first observed by Professor Beyrich, which the author has also discovered in many specimens of the same species. These were found in the quartzites of the Drabow mountains, and the intestine which runs down the interior of the median lobe or axis, from the glabella to the posterior margin of the pygidium, is either empty or full of a very fine clay. The chemical nature of this substance would be interesting, as giving, perhaps, some indications of the food of these crustaceans.

Our limits compel us to pass, without further notice, the very important section on the nature and ornaments of the shell or test of the trilobites, some portions of which furnish valuable materials not only to the geologist, but to the zoologist. The account of the metamorphoses which many of the trilobites are now shewn to undergo, is also well worthy of the study of the zoologist, as illustrating many particulars in this remarkable peculiarity of the articulata. In several species the author has followed the successive changes from the time when the young trilobite escapes from the egg* till it attained its full dimensions. In some this was not possible, as the animal in its early stages seems, like some recent crustaceans, not to have possessed a shell, and thus to have left no record of its first forms. The Sao hirsuta and Dalmanites socialis furnish the most complete series of changes, the young animal being represented merely by the head divided into three lobes, whilst the thorax is wanting or rudimentary, and no trace seen of the tail. In a second group, as Trinucleus ornatus and the Agnosti, even in the first period the head and pygidium are distinctly seen, but incomplete, and there is no trace of the thorax, of

* The eggs themselves are figured in Plate 27, fig. 1–3.

which the segments are only gradually developed. In some higher groups all the parts of the body are at all times recognisable, and the change is principally in the form and number of the segments. Such metamorphoses have now been established in sixteen genera and twenty-eight species. M. Barrande thinks that this number may be greatly increased by new discoveries, but would not extend it to the whole family of trilobites. Some naturalists have even endeavoured to call in question the fact altogether, though we must think without reason, when we take into account its certainty among the living families of crustaceans. M. Barrande refers such doubters to his collections for proof of its truth; but as few can take a journey to Bohemia for this purpose, we think the remarkable series minutely engraved in the plates 7, 18, 26, 30, may serve for their conviction, if studied without prejudice.

The geological distribution of these trilobites along with the other fossils was noticed by us in our former article on the introductory portion of M. Barrande's work. He now sums up his observations on this and other Silurian regions in the following general propositions. 1*st*, "In consequence of local conditions, the fossiliferous formations of the Silurian system present in each country a series of distinct stages, each characterized, either by the nature of the rocks which compose it, or by a particular fauna, more or less distinct (*tranchée*). 2*d*. These local stages, considered individually do not exhibit in general any complete or constant agreement, when we seek to establish a parallel between them, by comparing distant countries with each other. In other words, the local stages of different countries are distinguished from each other, either by the nature of their rocks, or by the zoological composition of their faunas, or by the order of the succession of these. Nevertheless, it cannot be overlooked that there always exist very numerous relations between the animal forms that constitute the mass of these local faunas, even at great geographical distances. 3*d*, If we group the local stages in each of the Silurian regions according to the sum of the analogies noticed among the fossils of all kinds that they contain, and in particular in accordance with the succession of generic and specific forms in the tribe of trilobites, we find everywhere three grand physical masses similar one to the other, and superimposed in the same order. These masses or groups are characterised by as many general faunas—that is to say, faunas whose extent embraces the whole Silurian world, and which present among themselves a striking harmony, in respect both of their zoological composition and the uniform order of their succession, wherever their presence has been determined. We distinguish these three Silurian faunas by the names of *Primordial* fauna, second fauna, third fauna. The first two divide unequally the geological height of the lower Silurian formation, whilst in the third we comprise, provisionally, all the beings buried in the superior division."

M. Barrande has represented the facts bearing on this subject, so far as the trilobites are concerned, in a very clear and striking manner, in Plates 50 and 51. His primordial fauna is by far the most distinct; no species, and in Bohemia only one genus, Agnostus (in Sweden also another, Amphion), of trilobites, passing from it into the higher beds. But we agree with him that this is no sufficient ground for separating the beds containing this fauna from the other Silurian rocks as a distinct formation. Still less can we, for a similar reason, separate the second and third faunas, or the lower and upper Silurian groups, connected as they are, not only by many genera, but even by several species, including, as we must do, those in his "colonies." On looking at the plate, the true physical cause of the great break in the zoological series is at once apparent. The primordial fauna is cut off by an enormous eruption of igneous masses (porphyries, &c.) which destroyed all organic beings in the limited basin of Bohemia. These are followed by conglomerates marking shallow seas, and a bottom on which trilobites could not live; and it is only when the appropriate sea-bottom of schists and quartzites returns that they again reappear in great abundance, but of course, after such a long interval, in new types and forms. His second division is closed in like manner by eruptions of trap; but these we would conjecture, from the nature of the connected rocks, both less extensive, and effecting less physical change on the sea-bottom, and, consequently, also less mutation in the co-existing organic world.

We cannot now enter further on the rich field for speculation which this portion of M. Barrande's work presents, or notice the important conclusions at which he arrives. Still less will our limits permit us to follow him in his critical review of the various systems of classifying the trilobites, or in his minute and elaborate descriptions of the genera and species found in Bohemia. This portion of his work, with the accompanying series of plates, must henceforth be in the hands of every practical geologist who wishes to make himself acquainted with the form and structure of these most ancient denizens of our globe. Even the zoologist, who wishes to review the varied forms of Articulate organization, will find it indispensable for his purpose, as containing not merely the largest mass of materials, but many interesting features in the form and structure of these animals which we do not remember to have seen mentioned elsewhere.

In conclusion, we would congratulate M. Barrande on this successful result of his long and laborious undertaking. An exile from his own land for loyalty to his prince, he has well repaid the hospitality with which Bohemia received him, and connected his name indelibly with her scientific history. But in his success we must confess that we feel a special interest, from the connection in which it stands with the geological history of the British Islands. M. Barrande tells us he was specially led to the study of these ancient rocks by reading the Silurian System of Sir Roderick Murchison, which proved to him, as to so many other geologists, a sure guide in unravelling the mysterious history of the oldest of known creations. The benefits he derived from this classic work of our distinguished countryman he now repays with interest; and we expect soon to see the influence of M. Barrande's valuable researches exhibited in new light dawning on many obscure points in the geological history of our own land. In this expectation we wish him all success in his labours, and shall look eagerly for the appearance of the two remaining volumes of this highly important work. We are glad to learn that the engraving of the plates for these volumes is now far advanced.

On Vesicles in the Abdominal Cavity and Uterus, containing a Mulberry-like Body rotating on its Axis, and on the Expulsion of the Ovisac from the Ovary. By MARTIN BARRY, M.D., F.R.S., F.R.S.E. (Communicated by the Author.)

Of such vesicles a very minute description has recently been given by Keber,* who found no fewer than eighty of them in seven-and-thirty rabbits. And large as the number of rabbits was, this indefatigable observer discontinued his researches only because no more of these animals could be obtained. He opened scarcely any rabbits without finding one or more of the vesicles in question. Their diameter was generally about $\frac{1}{2}'''$. Some were smaller, others as large as $1\frac{1}{2}'''$. The smaller were tolerably round, the larger ones mostly elliptical, sometimes tapered at one end; and some were bean-shaped. They had a fibrous membrane. Their position was either on the fimbriæ of the Fallopian tube, or on the tube itself, or on the peritoneum in its neighbourhood; sometimes on the horns of the uterus, and in several instances imbedded in the mucous membrane of the latter near its junction with the Fallopian tube. They were attached by a ramification of bloodvessels. A ciliated and vibrating epithelium lined the inner surface of their membrane. A mulberry-like body was seen in their interior, consisting of corpuscles bearing cilia, by means of which it rotated on its axis. The rotations of this body lasted from an hour and a half to two hours. Its diameter averaged $\frac{1}{60}'''$, that of its corpuscles about $\frac{1}{200}'''$. Nothing like uniformity was presented by the vascular condition of the sexual organs, which in this respect varied greatly. Keber has given other details, not required in this communication.

In my "Researches in Embryology" many years ago, vesicles such as those found by Keber were often seen im-

* In his work entitled "*De Spermatozoorum Introitu in Ovula,*" Königsberg, 1853.—The last number of this Journal briefly noticed Keber's observations on these vesicles, as well as those of the author of the present communication. The latter now gives a more particular account of them, and of some recent observations of his own.

bedded in the mucous membrane of the uterus, and attached by bloodvessels near the junction of the uterus and Fallopian tube. But being in search of *ova*, which it was important to obtain without delay, I again and again passed the said vesicles by, and perhaps might never have given them more particular attention, had it not been that the small size of one of them, by bringing its centre into view, revealed the phenomenon of a body rotating on its axis. The vesicle was elliptical and measured in length $\frac{1}{7}'''$. The rotating body had a diameter of $\frac{1}{50}'''$, its corpuscles measured about $\frac{1}{200}'''$. I watched it rotating for half an hour, though an hour and a half had elapsed after the rabbit had been killed before the examination of the rotating body was begun. Of this vesicle and what was seen of its contents I published an account, with a drawing, in 1839.* The observation was incidental, and the account given of it was far less complete than it would have been had I known of the rotating body sooner. Singularly enough, that body *entire* and *rotating* was seen by me but once. Elliptical brown punctate corpuscles, however, the debris of such a body, I afterwards repeatedly observed.

Keber is of opinion that whether found in the abdominal cavity or in the uterus, and however different in size, the vesicles in question are the same; and farther, that the vesicle in which I had incidentally observed a rotating body was one of these. In this opinion I agree with Keber.

What are the said vesicles containing a rotating body? Keber believes them to be *ova.*

When in 1839 I saw a vesicle which contained a mulberry-like body bearing a perfect resemblance to the essential part of the mammiferous ovum in several of its phases described by me at the same time—that body rotating on its axis—the thought naturally arose: Have we not here a mammiferous ovum exhibiting rotation like that of some of the lower animals? The resemblance, however, did not extend beyond the rotating body. The membrane of the vesicle was fibrous,—it was connected by bloodvessels with the uterus, instead of lying in its cavity unattached,—there was only one membrane

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* Phil. Trans., 1839, p 355, Pl. IX., fig. 151.

to be seen,—this was certainly not what had been the zona pellucida,—and the mulberry contained no large cell in its interior—my "queen-bee in the hive." I therefore did not venture to consider it an ovum. (But in 1841 I had the satisfaction to see from Müller's Archiv, that the said incidental observation of mine had led to the discovery of rotation in what was certainly the mammiferous ovum.*)

I therefore cannot agree with Keber, that the vesicles in question are *ova*. What then are they? For I am satisfied that he is right in saying—and he was the first to say—they arise *in the ovary*. I will now mention a few facts that may assist in determining what these vesicles really are.

Up to 1838 the cavity containing the mammiferous ovum in the ovary was known only as that of the Graafian follicle or Graafian vesicle. In that year† I made known the mode of origin of the Graafian follicle, and in 1841‡ made several additions which shew how it stands related to a "cell." The Graafian follicle arises in the following way. There is first seen a large cell. The nucleus of this divides into a large number of nuclei, which in colour, form, and size, are exactly like the early state of mammiferous red blood discs. From their origin in a mother-cell, these nuclei after their liberation are found in groups. They form cells which are elliptical at first, become more spherical, and sometimes tapered at one end. The number of these cells is countless. But very few of them are matured and make their appearance at the surface of the ovary, though the rudiments of an ovum are seen in all. They are highly elastic, and remarkably transparent. They acquire a vascular covering, and there is thus formed a Graafian follicle. Von Baer's "couche interne" of this follicle is the originally independent cell just referred to, and his "couche externe" is the vascular covering which that cell acquires. That cell I found to be common to all the Vertebrata, and in all these to arise, pass through stages, and acquire a vascular covering, in essentially the same way as in Mammalia. There is thus formed the capsule of the

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* Seen in one rabbit by Prof. Bischoff.

† Phil. Trans., 1838. ‡ Ib., 1841.

Bird, &c. This capsule is analogous to the Graafian follicle of Mammalia. The Graafian follicle is therefore not a structure peculiar to Mammalia, as had up to 1838 been supposed. The said originally independent cell—the foundation of both Graafian follicle and capsule—I proposed to call the *ovisac*.

There are several points connected with the ovisac to which, on this occasion, I ask particular attention. 1. The capillaries in ramifying on the ovisac often include minuter, or as I called them parasitic ovisacs, which thus come to *lie between* the membrane of a large one and its vascular covering. I once counted more than fifty in such a position in the capsule of a bird. 2. The ovisac *readily admits of removal* from its vascular covering, which, however closely applied, does not become connected,—there is no penetration of its membrane. 3. When research of the minutest kind is made on the mode of origin of the ovisac, its young membrane is found to be made up of nucleolated nuclei, which later stages shew to have had within them the elements of *fibre*.

In 1839 I published the following fact.* An ovary of the Hog, with a high degree of vascularity in all the parts, presented three ruptured Graafian follicles, with four on the point of bursting. None of these were distended beyond a moderate size. Bloody strings of a fleshy substance were hanging at the orifices of two out of the three ruptured Graafian follicles. In the infundibulum of this side there were several of the same kind of bloody masses of a string-like form, suggesting the idea of their having been rolled.† Some of the string-like masses found in the infundibulum, as well as those pendent at the orifices of the ruptured Graafian follicles, on being examined with the microscope, presented a multitude of ovisacs, varying in size from $\frac{1}{20}'''$ and less to $\frac{1}{4}'''$. Of one of these, and of its ovum, I gave a drawing‡. I added, "The presence of such objects in the infundibulum appears to be not unfrequent in the Hog. I have observed them also in the Cat."§

* Phil. Trans., 1839, pp. 319, 320.

† In connection with the *rolled* appearance of these masses, I referred to the muscular state at certain periods of the middle coat of the infundibulum.

‡ Phil. Trans., 1839, Pl. V., fig. 102.

§ Ib., p. 320.

No doubt, as I then suggested, the multitude of minute ovisacs thus found in the infundibulum are what from their position I termed parasitic, these having been involved in the rupture of a Graafian follicle, and thus expelled. Lying, however, as these do, between a larger ovisac and its vascular covering, the escape of the parasitic ovisacs implies the expulsion of the larger one. And it is very possible that it was this larger ovisac with its ovum that I have just mentioned as having been represented by a drawing.*

Whether such was the case, however, it matters not. All that I wish to shew from the said observation is simply this: That ovisacs in large numbers are found *outside* the ovary, and therefore that ovisacs *are expelled from that organ.*

But farther, I have reason to believe that in most instances the Hogs, in which are frequently found such ruptured Graafian follicles, have had *no connection with the male.* And lastly, from what I have since noticed in other Mammalia, and especially in the Rabbit, I am satisfied that the following is common to this class of animals, viz.—In the rutting season when there has been no connection with the male, the ovum does not escape from its ovisac; for *the ovisac itself is expelled from the ovary with the unfecundated ovum contained in it.*

Of what I had thus seen to happen in Mammalia on the expulsion of an ovum from the ovary in the rutting season, when there had been no connection with the male, I was reminded by Keber's facts. And the conviction arose, that the vesicles with a rotating body—certainly not *ova*—are *ovisacs.* In favour of such an opinion was the fibrous structure of their membrane,† and their usually large size. I have already published this view,‡ and have since received a

* Phil. Trans., 1839, Pl. V., fig. 102.

† In the fibrous structure of the membrane of the vesicles containing a rotating body, Keber foresaw an objection likely to be raised against his view that they are ova; the vitellary membrane (zona pellucida) never becoming fibrous. This objection has been met by my opinion, that they are not ova but ovisacs. For drawings which I gave in 1841 of young ovisacs present, in the nucleolated nuclei of which their membrane is at first composed, the elements of future fibre. (Phil. Trans., 1841, Pl. XXV., figs. 164 to 173.)

‡ In the last number of this Journal.

letter from Dr Keber informing me that he adopts it. He adds, that on becoming acquainted with my observations on the escape of ovisacs in the Hog, he examined several of these animals slaughtered by the butcher, and in the very first of them found three escaped ovisacs on the outside of the Fallopian tubes.

My health not admitting of much labour in microscopic research, I have lately requested for this purpose the assistance of a friend. He first examined two unimpregnated rabbits, recording and reporting the results, which I quote in his own words. In one rabbit, he says, "I found no trace of escaped ovisacs; but removed as many as fifteen without any difficulty from different parts of the ovaries. They were of various sizes, $\frac{2}{3}'''$ and under. They all were fibrous, ... contained one, two, or three ova, and were sufficiently clear to shew the ovum within when gently flattened." The other rabbit, five months old, he was informed had never had connection with the male. He brought me two vesicles from this rabbit. One of them, A, he says, "was still in the ovary, but formed a translucent glistening projection upon the surface. Its escape was almost spontaneous after the inclosing ovarian membrane had been torn." We examined this vesicle together. It was elliptical, about $\frac{2}{3}'''$ in length, and fibrous. It contained three ova, one of them well formed, the others smaller and apparently aborted. This vesicle was evidently an ovisac, freed from its vascular covering. The other vesicle, B, my friend remarks, "was lying at one extremity of the ovary, slightly *attached to its surface*, with the infundibulum in close proximity. There was therefore left upon its removal" [from the surface of the ovary] "a minute torn or abraded spot." Our joint examination of this vesicle yielded the following results, which are important as shewing in what respects a vesicle, B, *attached to the surface* of the ovary, resembled, and in what respects it differed from an ovisac (the vesicle A) almost spontaneously escaping from that organ. In size, B rather exceeded A, but had a diameter of less than a line. In the fibrous structure of their membrane, and in their elliptical form, B and A did not differ. There was neither "zona pellucida" nor anything that could be called an ovum in B. *But it contained a mulberry-like body such as I had seen rotating on its axis.*

These observations leave no doubt at all that the vesicles containing a mulberry-like rotating body have, as Dr Keber supposed, their origin in the ovary;—that they are not, however, ova, as he supposed them to be, but *ovisacs.*

The said vesicles then being ovisacs, it is to be presumed that the former ovum is represented by the rotating mulberry. How does the one become converted into the other? From what I saw in the Hog, it would seem that some of the first changes, after the expulsion of the ovisac from the ovary, are liquefaction of the yelk, absorption of the vitellary membrane, and enlargement of the germ vesicle and spot.* What follows I cannot say. But it is difficult to believe that there is anything in the ovum or ovisac so likely to produce a ciliated rotating mulberry-like body as the dividing and sub-dividing germ spot; for I shewed this spot to fill its vesicle by such divisions, and this before fecundation. An altered form of the germ spot, therefore, I believe to be represented by the said rotating body. The spot, as I have already said, is that of an *unfecundated* ovum. And in harmony with this is the important fact, that the rotating body in the vesicles in question, though perfectly resembling the mulberry in the fecundated ovum, is *much smaller,* and contains in its interior *no large cell with a nucleus, which nucleus, according to my observations, is the first appearance of what can be called the embryo.*†

As to what becomes of these escaped ovisacs with their remains of unfecundated ova, I am by no means of the opinion that any of them are ever fecundated in the Fallopian tube or uterus. My belief is that they are finally absorbed, for in the same localities you find corresponding vesicles connected by bloodvessels with the part where they are found, having a thinner membrane, and either no more than traces

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* Phil. Trans., 1839, p. 320, Pl. V., fig. 102 *f.*

† Von Baer's "primitive trace" exhibits a later stage, an altered form of the nucleus of my large cell first seen in the centre of the mulberry, and then passing to the surface.

of an epithelial lining and of a mulberry, or no trace of these at all. Such states were also noticed by my friend in two rabbits which he examined, besides those already mentioned. In one he found two vesicles distinctly attached "by blood-vessels to the fold of peritoneum inclosing the ovaries and between them and the fringe of the tubes. The capillaries running over the surface of these fibrous sacs were very plainly seen with the current of blood in them; yet they were so transparent as to admit of a full examination of the interior. . . . . No trace of cells or the mulberry-like body." A third vesicle in nearly all respects the same he found in another rabbit attached to the fimbriœ of the Fallopian tube.

Owen aptly termed the Infusoria a minute police,—their office being to take up and retain in organic life particles about to be lost from it.* This comparison may perhaps be applied to the capillaries that ramify over the vesicles containing a rotating body; but in the very opposite way. Instead of retaining them in organic life, the capillaries *lay hold* of these vesicles as foreign bodies to be expelled, and they accordingly take them up and effect their expulsion. In this, however, they seem to be assisted by the vesicles themselves. For as the rotations exhibited by a *fecundated* ovum belong to the changes essential to development, so, it may perhaps be said, do the rotations of the *un*fecundated mulberry-like body in its ovisac belong to the changes leading to dissolution.

The foregoing relates to the ovisac with an *un*fecundated ovum; the following to the ovisac *after fecundation.* I am about to give the substance of several more of the facts published in my second series of "Researches in Embryology" in 1839, viz.—

1. Fecundation of the mammiferous ovum takes place *in the ovary.*†

2. A large aperture is seen in the ovisac just before the expulsion of the Rabbit's *fecundated* ovum from the ovary.‡

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* Hunterian Lectures. † Phil. Trans., 1839, p. 350. ‡ Ib., Pl. V., fig. 98.

3. In Mammalia the ovisac does not continue long in the ovary after the expulsion of the fecundated ovum. A few hours after the Rabbit's ovum has been discharged, if lateral pressure be applied, the ovisac escapes from the thick vascular mass which has no connection with it. Of an ovisac thus removed with its large aperture, I gave a drawing.* Soon after, *the ovisac is no longer met with in the ovary.* There is now seen protruded from the centre of what was formerly the Graafian follicle, a mammillary process, noticed by several observers, very accurately figured by De Graaf, apparently mistaken by Cruikshank for the ovum, and not inappropriately compared to a sort of hernia by Coste. This mammillary process consists solely of an inverted portion of the vascular spongy substance which previously constituted the covering of the ovisac. In the Rabbit the expulsion of the ovisac seems to take place in three or four days after the fecundated ovum has escaped; in the Sheep and Goat not so soon.† For the vesicle described by Dr Pockels as remaining in the incipient corpus luteum eight days and more after the expulsion of the ovum in the Sheep and Goat, was evidently my ovisac.

4. The ovisac therefore can take no part in the formation of the corpus luteum.‡

The large and sometimes elliptical aperture in the ovisac, which I figured,§ is obviously for the purpose not only of admitting the fecundating element, but also for the passage through it of the *fecundated* ovum. (Such an aperture is not required where, as in the case of the *un*fecundated ovum, the latter continues in its ovisac—the ovisac escaping with its ovum; though it is by no means improbable that such an aperture may be intimated even here.)

We have thus seen a vesicle—my ovisac—to exist in the ovary,—to be unconnected with its vascular covering,—to have a fibrous structure,—and, either with the ovum or after it, to be expelled from the ovary. This is in Mammalia,

* Phil. Trans. 1839, Pl. V., fig. 98.
† Ib., 1839, p. 318.
‡ Ib., p. 350, § 261.
§ Ib., Pl. V., fig. 98.

where the expelled ovisac is probably absorbed. I have shewn a corresponding vesicle to be common to the other Vertebrata, and I am by no means disposed to limit the ovisac to this class of animals, believing it to correspond to the "schaalenhaut" of German authors in the lower ones. Its final destiny in different animals may be very different. But analogy forbids the supposition that, exist where it may, the ovisac in any two animals essentially differs in its relations to what may be present of a vascular covering. It is equally improbable that while the ovisac is expelled from the ovary in Mammalia, it remains in that organ elsewhere.

The Physical Geography of Hindostan. By Dr GEO. BUIST, Bombay. Communicated by the Author.

General Description.—Our recent conquests have extended our north-west frontier to almost everywhere beyond the Indus, and the British dominions now stretch from the sea to the mountains, all around from Soonmayance in Scinde to Arracan in Burmah; and the region to which the following remarks pertain is the same in its physical as its political boundaries and area. It forms a vast irregular lozenge, composed of two triangles, one of them nearly equilateral, resting on opposite sides of the 22d parallel. The peninsula of Hindostan proper—of about 1200 miles each side, extending from the latitude of Cutch and Calcutta, and so southward to Ceylon, in latitude 7°—constitutes the southernmost of these and is bounded to the south-east and south-west by the Bay of Bengal and the Arabian Sea; the other, which rests on this, base to base, is obtuse-angled and scalene, its apex reaching north beyond Attock, and its base extending along the shores of Scinde to Cape Monze, and those of the Bay of Bengal to the mountains eastward of Chittagong, or from the 67th to the 90th eastern meridian. It comprises an area of 1,309,200 square miles, surrounded by a boundary of 11,260, or one-half the circuit of the globe. Of these square miles 800,788 belong to England, 508,412 to native states.

The features of this vast country are almost endlessly diversified. A huge range of mountains walls it in on the north-east, north, and north-west, with a general equatorial direction, bending at the extremities south-east and south-west. A magnificent chain, constituting the Western Ghauts, runs nearly parallel to the shore, along the whole western seaboard, from Goozerat south to Ceylon. A large equatorial mass, forming the Vindergah range on the north and Satpootra on the south, bending eastward from this, constitutes the basins of the Taptee and Nerbudda. The Gomsoor and Rajmahal hills, which bound the delta of the Ganges on the west, constitute almost independent masses; and the range along the eastern side of the peninsula towards the seaboard is, as compared to the Western Ghauts, irregular in structure and inconsiderable in elevation. Shelving or sloping gently from the inner sides of the latter of these, is the vast table-land of the Deccan, resting on the highlands of Malwa on the north, under the 20th parallel, and extending eastward and southward, till terminated by the mountain spur which stretches from the Nhilgherries towards Madras. Stretching again from the base of the mountains on both sides of the peninsula on to the shore, and so extending all round the sea-coast, is a low border on the eastern or Coromandel, and the Concan on the western or Malabar coast. It varies from 5 to 50 miles in breadth, and its average elevation is about 30 feet above the level of the sea. A large portion of it is obviously of very recent marine origin; and on the northern and southern portion of the shores of Western India it is broken up into numberless islands, of which the group of fourteen—of which Bombay is one—is the best known and most beautiful.

It will be thus seen that the peninsula of Hindostan consists of three distinct parts,—a central table-land, of an average elevation of about 1500 feet, and a maximum of about 2500 feet, sprinkled with magnificent isolated conical hills, some 2000 above the plain and 4000 above the sea, of a vast circumvallation of mountains, spreading out into a great mass on the north-west, and presenting on the west two stupendous groups, rising at Mahabaleshwar, near Bombay, under the 18th parallel, to the elevation of 4500 feet,—the Nhilgherry group, under the 12th parallel, attaining an altitude of 8500 feet,—and, thirdly, of the low land on the seaboard betwixt the foot of the hills and the shore.

Without at present taking into account the Sooliman and the Himalaya mountains, India, beyond the limits of the peninsula northward, exhibits four grand divisions of surface,—1*st*, The great river deltas of the Indus and Ganges, consisting of almost pure alluvium, yearly adding to its mass, and which furnish by far the most fertile portions of the country; 2*d*, The Doabs, which may be described as the converse of the deltas—the latter being the rich lands which lie around the mouths, the former those which separate the branches of our principal rivers; both being to a greater or less extent subject to inundations, the Doabs being particularly accessible to artificial irrigation; 3*d*, The Great Desert, which lies to the eastward of the Indus, and southward of the Sutlej, towards Delhi, and which long formed the defence of the British frontier; and, lastly, The Terai, or gravel belt, which skirts the base of the mountains,—a tract of comparatively inconsiderable size, but so singular in point of structure as to be deserving of a separate notice.

The Terai, or Tauri, is a large gravel belt, filling, to the depth of from 15 to 150 feet, a narrow, basin-shaped hollow, from 5 to 15 miles in breadth, and from 500 to 600 in length, skirting the base of the Himalayas. It is so penetrable to water, that rivers, after traversing it for a short distance, sink down and disappear under its surface, re-appearing again when a fault, dyke, or other obstruction, is met with, once more to disappear when this is passed. The marshes thus formed are so malarious, that the husbandmen by whom portions of the Tarai are tilled hasten away from it as evening approaches, and make their abode high up amongst the hills. The insalubrious character of this singular region, at certain seasons of the year, pervades the vast Saul forests which skirt its margin all along; they are waterless, rivers sinking beneath them, and emerging in the Terai; and Nepaul is girt around by a border at times so dangerous to human life that for months together no one attempts to traverse it.

River Systems of India.—In India we have two stupendous river systems—the Himalayan and Hindostanee—drawing their supplies from totally separate sources, and traversing or surrounding the whole of the districts subject to the visitation of famine. The Indus, with its five magnificent tributaries which intersect the Punjaub, and the Ganges and Burrampootra, with their gigantic branches, derive their principal supplies from the melting of the snows; and the more fiercely the sun shines on the hills, and the more insufferable that are the heats below, the more plentifully do these gelid storehouses give up their treasures. The whole of the Hindostanee system of rivers, again, consisting of the Sabermutti, the Mhye, the Nerbudda, the Taptee, all discharging themselves into the Gulf of Cambay, in Western India; the Godavery, the Kistna, and the Cauvery, falling into the Bay of Bengal, originate in the western mountains, and are fed by the rains which fall over these, to the extent of 100 inches on an average, during the months of June, July, and August. Both systems, whether fed by snow or rain, are in flood at the same period of the year, that being just the season when moisture is most required. Both draw their supplies from mountains too rocky or barren to require moisture, and too steep to retain it, and which send to the ocean, through tracts of the finest country in the world, supplies of water sufficient to transform them into one universal garden.

The following table is given by Hamilton of the probable length of some of the rivers of India:—

	Miles to the sea.
1. Indus,	1700
2. Jumna (to its junction with the Ganges, 780 miles),	1500
3. Sutlej (to the Indus, 900),	1400
4. Jhylum (ditto, 750),	1250
5. Gunduck (to the Ganges, 450),	980
6. Godavery,	850
7. Krishna,	700
8. Nerbudda,	700
9. Mahanuddy,	550
10. Tuptee,	460
11. Cavery,	460

Remarkable Cataracts.—Gairsuppa, Western Ghauts, top of fall to surface of basin, 888 feet, depth of basin, 300—total, 1188; from 300 to 600 feet across during the rains. Yeanna, Mahabaleshwar, 600 feet. Cavery, Mysore, 300 feet. Bouti, in Bundelcund, 400 feet. Katra, in Bundelcund, 398 feet. Chai, in Bundelcund, 362 feet. Keuti, in Bundelcund, 272 feet. Garsippa, near Honoor, 1000 feet, and 60 feet across.

When we find India generally talked of as one country of moderate extent, and nearly uniform condition and characteristics, it is not wonderful that the phenomena of the atmosphere should be spoken of with as much looseness as the geography of the land. The climate of India is in reality still more various and diversified than the features of the country. In the south, showers are frequent all the year round; on the southern Coromandel coast three months of violent rain occur in winter, the rest of the season being dry; while a few degrees to the north of this, on both sides of the Bay of Bengal, and all over Western India, the precise converse of this is the case. In Central India the rain becomes extremely light, and occurs mostly about midsummer; in the north there are both the summer and winter rains; in Scinde and Beloochistan there is no rainy season whatever, and the heavy showers which occur irregularly, and at intervals of years, are productive of sickness, and considered injurious to the country.

To go, however, more into detail:—From the conjoined influences of the heat of the sun and the rotation of the earth, there are two vast currents of air constantly circling round the globe from east to west, called the north-east and south-east trade-winds, the two being separated from each other by a belt of turbulent and irregular currents, and frequent precipitation, called the rains, calms, or variables. These three great bands of air move somewhat to the north and south, according as the sun is to the northward or southward of the line; and where they impinge upon a continent or peninsula stretching towards the equator, a branch is broken off, and a current, varying according to the season of the year, produced, called a monsoon. On the western side of India, north to the Gulf of Cutch, and on the western shore of Burmah and the peninsula of Malacca, this blows, for betwixt two and five months in summer, according to the latitude, from south-west; for the greater part of the rest of the year from north-west, an interval of storms and calms occurring in both cases at the period of change. It is usually held that this takes place about a week or ten days after the passage of the sun northward or southward over the parallel of the place, and that the rains which always accompany it follow and retire a few days afterwards. On the eastern side of the peninsula again, from Ceylon to considerably northward of Madras, lying in the lee as it were of the land, the monsoons blow from north-east and south-east, the former of which occurs in midwinter, being their rainy season.

Few things can be more striking than the state of the atmosphere or the aspect of the sky just as these periodical alterations are about to arise. Taking what appears at Bombay as an example: from the beginning of November to the end of May the sky has been perfectly cloudless, and not a shower has fallen. Regular sea and land breezes setting in before noon and daybreak respectively, the former blowing from north-west for ten or twelve hours, the latter from due east for five or six, with intervals of calm between, have filled up the day and night. While this state of matters still continues, and not the slightest indication is given of coming change, the stranger observes to his astonishment a sudden and simultaneous bustle amongst the whole community. The tents occupied by the troops, and the flimsy dwelling-places which had hitherto afforded accommodation to the European population, are suddenly pulled down and swept away, as if their occupants were fleeing before some fearful pestilence. The most substantial buildings, if thatched, have their roofs stripped off and renewed, and in any case have them thoroughly repaired, while all doors and windows facing the south-westward are boarded up, matted over, or in some way or other secured. Square-rigged vessels strike their upper masts, lower their yards, and make immediate provision for a storm, while as yet there is nothing whatever to warn the stranger of coming change; and the lighter native craft are hauled up beyond the reach of the waves, and thatched over with a thick roofing of palmyra leaves. Large clouds at length begin to make their appearance daily about noon over the western mountains, and advancing up the sky eastward, right in the teeth, as it would seem, of the wind then blowing, exhibit the most magnificent display first of sheet, afterwards of forked lightning. This goes on from day to day for about a week, the electrical displays becoming more vivid and intense every night. Until the rains actually fall, the clouds invariably disappear immediately after dark, and two hours after the sun has gone down surrounded by the emblems of coming tempest, the stars shine out everywhere down to the very edge of the horizon, and not a flock or film of vapour is to be seen staining the deep blue of the serene expanse from side to side of the firmament. Suddenly, and in general after a day of unusual tranquillity, a little after sunset, a blast at once darts forth from the east, followed by a gush of rain as if the windows of heaven had been opened, the thunder roars and lightnings flash incessantly, the quivering light of a continuous succession of flashes being sometimes sufficient for five or ten seconds on end to permit the smallest print to be read. Sometimes it shoots upwards from the earth, sometimes it seems to rain down in long streams, like a string of red-hot beads, reaching from the clouds to the sea; most frequently it darts in long zig-zags horizontally from cloud to cloud, or bursting in all directions from a single point like a shower of coruscations shot on every side. This state of matters generally lasts from one to two hours, when the wind veers round to south-westward, blowing with increased steadiness and diminished force, and the voice of the thunder, which had just before pealed in a succession of tremendous claps or roars, is heard lowly bellowing in the distance.

It may be mentioned in passing that although all our continued storms blow on us from the south-west, and the sea breezes during the fair weather are north-westerly, that our casual blasts invariably burst upon us from the mountains to the east of us, as if these formed the grand magazine of thunder and storm. The first burst of the monsoon seldom lasts more than a single night and part of a day, and the second dawn presents the most wonderful change in the scene that can be imagined. The burnt and parched earth seems now washed and refreshed everywhere, long spikes of grass of the tenderest green already shoot up from what a few days before were brown and barren plains; deep and filthy pits and unseemly tracts, half choked up with rubbish, straw, and withered leaves, are now the basins of pellucid pools and lakes, or the channels of majestic streams. The rays of the sun, no longer fierce and intolerable as they were a week before, shaded by intervening vapours or transient clouds, present that interminglement of alternating light and shade in the landscape which, beautiful in itself, becomes doubly delightful from the contrast it exhibits to the uninterrupted and unceasing glare of the previous part of the year. After a few days' weather of this sort the rains return with redoubled violence, and continue to pour down for forty or fifty days, at an average of above an inch a-day, the ordinary fall in June, July, and August, amounting at Bombay to about 70 inches. Within a week or ten days of the commencement of the rains, so soon as the surface of the soil is fairly saturated, and occupied everywhere by rivulets or pools of standing water, the whole earth seems to swarm with fish. They are of four or five different varieties, such as abound in the sea along-shore, and can live either in fresh or salt water. They vary in size from an inch in length to that of the forefinger, and are caught in myriads in baskets or in nets affording sport to the boys, and an agreeable article of food. Though their appearance has been mentioned by every one who has attempted to describe the rains for the last two centuries, it has never been so satisfactorily accounted for as could be desired. Colonel Underwood of the Madras Engineers, mentions a case when he was overtaken by a furious shower in the midst of the dry season, when the earth was at once covered with fish, which must have fallen from the heavens. But this scarcely seems to account for those which appear some ten days after the burst of the monsoon. Equally remarkable with this, though without its mystery, is the appearance of myriads of frogs of the most enormous dimensions, which occurs at the opening of the rains. At night their croakings fill the air whenever a shower falls; and they are seen in hundreds by the margins, or in the waters of every pool—at times resting on the lotus leaf, at times hurrying from the pursuit of the water-snakes which hunt and devour them. They are of a bright greenish yellow, and measure from six to seven inches from snout to vent, often bounding from six to nine feet at a spring. The rains slacken off early in August, and after the first full moon an offering is made, and a festival held by the natives to propitiate the ocean god, and vessels laid up in the end of May prepare for sea. After some weeks of open weather the Malabar coast is usually visited in the end of September or beginning of October by a furious burst of thunder, rain, and easterly wind called the Elephanta, from its occurring as the sun enters the constellation of the Elephant, this finally closing the rainy season.

On the Bengal side the rains are about a week later in setting in than at Bombay. The amount of fall at Calcutta is nearly the same, but seems more violent while it lasts, and is somewhat less continuous. Along the whole of Eastern and part of Central India, the rains are preceded by furious whirling squalls, called north-westers, from their coming down from the direction of the Himalayas, as our eastern squalls do from the Ghauts; three or four of these occur during the months of April and May, and are frequently accompanied by furious hail-storms, the hail being on an average about the size of walnuts, frequently that of duck's eggs; single hailstones have occasionally been found from one to three pounds in weight. There are, indeed, four cases on record within the last 70 years of masses of ice having fallen from the firmament of from half-a-ton to a ton-and-a-half in weight. Recent observations have shewn that the maximum fall of rain occurs, as might be expected, at the ordinary altitude of the principal layers of rain cloud, between 3000 and 5000 feet above the level of the sea, and the amount of fall regularly decreases above this as the higher regions of air are attained. The discharge where this sea of vapour impinges on a cold mass of mountains is tremendous. At Mahableshwar it amounts to betwixt 200 and 300 inches, it exceeds 200 on the same level at the Nheilgerries, and at Cheraponge in the Cashia Hills north-west of Calcutta there is an average fall of no less than 610 inches, above 20 feet occasionally falling in the month of June.

In the north of India there are both winter and summer rains, though the former are always the lighter of the two.

The regions to the leeward of the mountain walls, against which the clouds borne up from the sea first dash and discharge themselves, are comparatively dry, and the suddenness with which the transition takes place is often most remarkable. At Paunchghunny, 500 feet lower down, and ten miles farther east than Mahabaleshwar, where from 250 to 300 inches fall, they have seldom more than 20 inches, while the average of the table-land of the Deccan scarcely exceeds 25. When the rain clouds approach the arid plains of Scinde and Cutch, they appear to ascend and become absorbed by the air, passing on to precipitate themselves on the mountains to the northward. There is much reason to believe that the fall of rain is diminished by the absence or destruction of trees. Were vegetation sufficiently fostered in Scinde by means of irrigation, it might cause it to have its regular rainy season like the lands around.

Two events strike with surprise the ornithologist on the approach of the monsoon. Nearly all the kites, hawks, vultures, and carrion birds disappear from the sea-coast, while the crows begin to build their nests and hatch their young just at the season that seems most unsuitable for incubation, when the eggs are often shaken out, or the nests themselves are destroyed by the storm, and the poor birds are exposed in the performance of their paternal duties to all the violence and inclemency of rain and tempest. At the instigation of a sure and unerring instinct, the carnivorous birds, as the rains approach, withdraw themselves from a climate unsuitable to the habits of their young, betaking themselves to the comparatively dry air of the Deccan, where they nestle and bring forth in comfort, and find food and shelter for their little ones. The earth, once saturated with rain in the low country, abounds in grubs, snails, and worms, the food of the young crows, which the parents pick up in the soft and moistened soil, the rising generation coming forth just as the means of supplying them with suitable sustenance become plentiful. The scenes connected with this, which follow the conclusion of the rains, are curious enough. While the Mahommedans bury, and the Hindus burn, the Parsees expose their dead in large cylindrical roofless structures called Towers of Silence, where birds of prey at all times find an abundant repast. Their family cares and anxieties over for the season, the carrion birds, which had left in May for the Deccan, return in October to Bombay, and make at once for the usual scene of their festivities, now stored with a three months' supply of untasted food. As they appear in clouds approaching from the mainland, the crows, unwilling that their dominions should be invaded, hasten in flocks to meet them, and a battle ensues in the air, loud, fierce, and noisy; the flapping of the wings, the screaming and cawing of the combatants resounding over the island, till the larger birds succeed, and having gained the victory, are suffered thenceforth to live in peace.

It is just after the rains have well set in, that those beautiful exhibitions of thousands of fire-flies flashing out in concert become visible. These brilliant little insects are generally seen dancing alone amongst shrubs and underwood, occasionally congregating in vast multitudes around isolated trees, which they at times render wholly luminous. At times the whole countless host flash out for a few seconds, and simultaneously, at intervals of similar amount, becoming dark again, and so they flash and flash for hours on end. Sometimes they shoot in long columns into the air, like the coruscations of fire-works, becoming bright and dark by turns, or having reached a considerable altitude, they seem to pour down in a shower of sparks.

Principal Falls of Rain in India—Eastern India and Bay of Bengal.

	Height.	Lat.	Long.	Fall of Rain.
Cheerapoonj, . . .	4500	25° 16′	91° 43′	610 in.
Sylhet, ...	5000	24° 40′	92° 40′	209 „
Tavoy, ...	sea level.	14° 5′	98° 10′	208 „
Moulmein, . . .	sea level.	16° 30′	97° 37′	175 „
Sandowy, . . .	...	18° 26′	94° 18′	178 „
Akyab, . . .	sea level.	20° 8′	92° 54′	155 „
Darjeeling, . . .	7000	27° 3′	88° 18′	125 „

Shores of Western India.

	Height.	Lat.	Long.	Fall of Rain.
Mahabaleshwar, . .	4500	17° 43′	74° 35′	248 in.
Attagherry, . . .	2200	11° 25′	...	170 „
Kandalla, . . .	1740	18° 30′	74° 30′	168 „
Untraymallay, . .	6000	11° 30′	76° 20′	164 „
Dapoolee, . . .	900	18° 33′	74° 2′	138 „
Angara Kandy, .	Malabar Coast.	9°	76° 30′	124 „
Cannanore, . . .	Ditto	12°	75° 20′	121 „

Average fall of Rain—At Bombay for 30, and Calcutta and Madras for 8 years, near the level of the sea :—

	Madras.	Bombay.	Calcutta.
January, . . .	3.50	.0	0.71
February, . . .	2.00	.0	0.55
March, . . .	0.25	.0	1.10
April, . . .	0.22	.0	2.95
May, . . .	5.00	.0	4.59
June, . . .	1.80	22.13	12.74
July, . . .	2.80	24.88	13.15
August, . . .	3.30	16.77	16.82
September, . . .	5.50	11.05	7.83
October, . . .	9.40	1.25	4.83
November, . . .	10.30	.0	.82
December, . . .	8.20	.0*	.50
Total, . .	52.27	76.08	66.59

Remarkable Falls of Rain in India and other parts of the World.—At Geneva, 25th October 1822, 32 inches fell in twenty-four hours; at Flangurques, 6th September 1801, 14 inches fell in eighteen hours; on the 20th May 1827, 6 inches fell at Geneva in three hours; at Perth, on the 3d August 1829, four-fifths of an inch fell in half-an-hour; on the 22d November 1826, nine-tenths of an inch fell at Naples in thirty-seven minutes.—Forbes, *Rep. Brit. As.* 1840.

In India.—At Mahabaleshwar, in 1834, 302 inches fell in one hundred days; on the 4th of October 1846, 10 inches fell at Chittledrooj in twenty-four hours; at Bombay, in 1844, 7½ inches fell in twenty-four hours; 2 inches fell in seventy minutes on the 1st, 9.43 inches on the 10th, and 12 inches on the 26th July 1849.—Sykes, *Phil. Trans.* 1850; *Rep. Brit. As.* 1849.

At Rajkote, on the 26th and 27th July 1850, 26 inches fell in twenty-four hours, and 35 inches in 36 hours; 7 inches fell in one hour and a half at Ahmed.

With this general review of the principal physical features and climate of India, we may next pass to some of the leading peculiarities of the ocean which surrounds it, and here I may perhaps be permitted to quote from what has already appeared in the Transactions of the Bombay Geographical Society, a work so little known in this country, that there is

* Occasional showers occur at Bombay sometimes all the year round, of which no account has been published in the Register. The majority of years are rainless from October to June.

not much risk of its having fallen beforehand in the way of the general reader.

"It is more than probable that besides the currents occasioned by the trade-winds, monsoons, and sets of the tides—we have a group of movements intermingled with these," dependent mainly on evaporation. When it is remembered that on the western shore of the Arabian Sea, including in this the Red Sea and Persian Gulf, from the line northward, we have an expanse of coast of no less than 6000 miles, and a stretch of country of probably not less than 100 miles inland from this, where the average fall of rain does not amount to four inches annually, where not one-half this ever reaches the sea, and where to the best of our knowledge, the evaporation over the ocean averages at least a quarter of an inch daily all the year round, or close on eight feet annually, some idea of the enormous abstraction of water in the shape of vapour may be formed. On the assumption that this extends no further, on an average, than 50 miles out to sea, we shall have no less than 39 cubic miles of water raised annually in vapour from the northern and north-western side of the basin, which must be supplied from the open ocean to the south, or the rains on the east. The fall of rain on the western side of the ridge of the mountain chain from Cape Comorin to Cutch averages pretty nearly 180 inches annually, and of this at least 160 is carried off to the sea: that on the Concan to 70 inches, of which probably 30 flow off to the ocean; or betwixt the two over an area of twenty miles from the sea-shore to the Ghauts, and about 1200 miles from north to south, or an area of 24,000 square miles in all, we shall probably have an average discharge of nine feet, or close on forty cubic miles of water,—an amount sufficient, were it not diffused, to raise the sea on our shores three feet high over an area of 72,000 square miles.

The waters of the ocean cover nearly three-fourths of the surface of the globe; and of the thirty-eight millions of miles of dry land in existence, twenty-eight millions belong to the northern hemisphere.* The mean depth of the ocean

* Since the above was written, Lieutenant Walsh, of the United States Navy, has sounded to the depth of about six miles, and in October 1852, soundings were made in Lat. 46° 49′ S., long. 37° 6′ W., from on board Her Majesty's Ship *Herald*, with an American line, to the depth of 7706 fathoms, or above 7 miles.

is somewhere about four miles—the greatest depth the sounding line till of late has ever reached is five-and-a-quarter miles. The mean elevation of the land again is about one thousand feet—the highest point known to us is nearly as much above the level of the sea, as the greatest depth that has been measured is below it. The atmosphere again surrounds the earth like a vast envelope: its depth, by reason of the tenuity attained by it as the superincumbent pressure is withdrawn, is unknown to us,—but is guessed at somewhere betwixt fifty and five hundred miles, its weight and its constituent elements have been determined with the utmost accuracy. The weight of the mass is equal to that of a solid globe of lead sixty miles in diameter. Its principal elements are oxygen and nitrogen gases, with a vast quantity of water suspended in these in the shape of vapour; and communicating with these a quantity of carbon, in the form of fixed air, equal to restore from its mass many-fold the coal that now exists in the world. In common with all substances, the ocean and the air are increased in bulk, and consequently diminished in weight, by heat; like all fluids, they are mobile—tending to extend themselves equally in all directions, and to fill up depressions in whatever vacant spaces will admit them; hence, in these respects, the resemblance betwixt their movements. Water is not compressible or elastic, and it may be solidified into ice, or vapourized into steam; air is elastic—it may be condensed to any extent by compression, or expanded to an indefinite degree of tenuity by pressure being removed from it—it is not liable to undergo any change in its constitution beyond these, by any of the ordinary influences by which it is affected. These facts are few and simple enough—let us see what results arise from them. As the constant exposure of the equatorial regions of the earth to the sun must necessarily here engender a vast amount of heat,—and as his absence from the polar regions must in like manner promote an infinite accumulation of cold,—to fit the entire earth for a habitation to similar races of beings, a constant interchange and communion betwixt the heat of the one and cold of the other must be carried on. The ease and simplicity with which this is effected, surpass all description. The air heated near the equator by the overpowering influence of the sun, is expanded and lightened: it ascends into upper space leaving a partial vacuum at the surface to be supplied from the regions adjoining. Two currents from the poles towards the equator are thus established at the surface, while the sublimated air, diffusing itself by its mobility, flows in the upper regions of space from the equator towards the poles. Two vast whirlpools are thus established, constantly carrying away the heat from the torrid towards the icy regions, and these becoming cold by contact with the ice, carry back their gelid freight to refresh the torrid zone. Did the earth, as was long believed, stand still while the sun circled round it, we should have two sets of meridional currents blowing at the surface of the earth directly from north and south towards the equator, in the upper regions flowing back again to the place whence they came. On the other hand were the heating and cooling influences just referred to to cease, and the earth to fail in impressing its own motion on the atmosphere, we should have a furious hurricane rushing round the globe at the rate of 1000 miles an hour—tornadoes of ten times the speed of the most violent now known to us, sweeping everything before them. A combination of the two influences, modified by the friction of the earth, which tends to draw the air after it, gives us the Trade-Winds—which sweep round the equatorial region of the globe unceasingly at the speed of from ten to twenty miles an hour: the aerial current, quitting the polar regions with the comparatively tardy speed from east to west imposed on it by the velocity due to the 70th parallel, is left behind the globe, and deflected into an oblique current as it advances southward, till, meeting the current from the opposite pole near the equator, the two combine and form the vast stream known as the Trades,—separated in two where the air ascends by the belt of variable winds and rains. Impressed with the motion of the air constantly sweeping its surface in one direction, and obeying the same laws of motion the great sea itself would be excited into currents similar to those of the air were it not walled in by continents, and subjected to other control. As it is, there are constant currents flowing from the torrid towards the frigid zone, to supply the vast mass of vapour there drained off; while other whirlpools and currents, such as the gigantic Gulf Stream, come to perform their part in the same gigantic drama. The current just named sweeps from the Cape of Good Hope across the South Atlantic to the Gulf of Mexico, and by the Straits of the Bahamas. Here it turns to the eastward again, travelling along the coast of America at the rate of from forty to a hundred miles a day: it now stands once more across the Atlantic, and divides itself into two branches—one finds its way into the Northern Sea, warming the adjoining waters as it advances, and turning back, most likely to form a second great whirlpool, rejoining the original stream near Newfoundland. The main branch seeks the northern shores of Europe, and, sweeping along the coast of Spain and Portugal, travels southward by the Azores to rejoin the main whirlpool. The waters of this vast ocean river are to the north of the tropic greatly warmer than those around: the climate of every country it approaches is improved by it, and the Laplander is enabled by its means to live, and cultivate his barley in a latitude which everywhere else, throughout the world, is condemned to perpetual sterility. But there are other laws which the great sea obeys, which peculiarly adapt it as the vehicle of interchange of heat and cold betwixt those regions where either exists in excess. Water, which contracts regularly from the boiling point downwards, at a temperature of 40° has reached its maximum of density, and thence begins to grow lighter. But for this beneficent provision, the various recesses of the frozen ocean would be continually occupied with a fluid, at the freezing point, which the least access of cold would convert into one solid mass of ice. The non-conducting power of water, which at present acts so valuable a part in the general economy, so far from being a blessing would be a curse. No warmth could ever penetrate to thaw the foundations of the frozen mass—no water find its way to float it from its foundations, so that, like the everlasting hills themselves, rooted immoveably in its place, every year adding to its volume, the solid structure would continually advance to the southward, hermetically sealing the Polar Ocean, thus condemned to utter desolation, and encroaching on the North Sea itself. Under existing circumstances, so soon as water is cooled down to 40° it sinks to the bottom, and, still eight degrees warmer than ice, it attacks the bases and saps the foundations of the icebergs—themselves gigantic glaciers which have fallen from the mountains into the sea, or which have grown to their present size in the shelter of bays and estuaries, and by accumulations from above. Once forced from their anchorage, the first storm that arises drifts them to sea, where the beautiful law which renders ice lighter than the warmest water enables it to swim, and floats southward a vast magazine of cold to cool the tepid fluid which bears it along,—the evaporation at the equator causing a deficit, the melting and accumulation of the ice in the frigid zone giving rise to an excess of accumulation, which tends, along with the action of the air, and other causes, to institute and maintain the transporting current. These stupendous masses, which have been seen at sea in the form of church spires and Gothic towers and minarets, rising to the height of from 300 to 600 feet, and extending over an area of not less than six square miles, the mass above water being only one-tenth of the whole, are often to be found far within the tropics. A striking fact dependent on this general law, has just been brought to light; there is a line extending from pole to pole at or under the surface of the ocean, where an invariable temperature of 39°·5 is maintained. The depth of this varies with the latitude; at the equator it is 7200 feet—at lat. 56° it ascends to the surface, the temperature of the sea being here uniform throughout. North and south of this the cold water is uppermost, and at lat. 70° the line of uniform temperature descends to 4500. But these, though amongst the most regular and magnificent, are but a small number of the contrivances by which the vast and beneficent ends of Nature are brought about. Ascent from the surface of the earth produces the same change in point of climate as an approach to the poles; even under the torrid zone, mountains reach the line of perpetual congelation at nearly a third less altitude than the extreme elevation which they sometimes attain: at the poles, snow is perpetual at the ground, and at the different intervening latitudes reaches some intermediate point of congelation betwixt 1000 and 20,000 feet. In America, from the line south to the tropics, as also in Africa, within similar latitudes, vast ridges of mountains covered with perpetual snow, run northward and southward in the direction of the meridian right across the path of the Trade-Winds. A similar ridge, though of less magnificent dimensions, traverses the peninsula of Hindostan, increasing in altitude as it approaches the line,—attaining an elevation of 8500 feet at Dodabetta, and above 6000 in Ceylon. The Alps in Europe and the gigantic chain of the Himalayas in Asia, both far south in the temperate zone, stretch from east to west, and intercept the aerial current from the north. Others of lesser note, in the equatorial or meridional, or some intermediate direction, cross the paths of the atmospherical currents in every direction, imparting to them fresh supplies of cold, as they themselves obtain from them warmth in exchange; in strictness, the two operations are the same. Magnificent and stupendous as are the effects and results of the water and of air acting independently on each other, in equalising the temperature of the globe, they are still more so when combined. One cubic inch of water when imbued with a sufficiency of heat, will form one cubic foot of steam—the water before its evaporation, and the vapour which it forms, being exactly of the same temperature, though in reality, in the process of conversion, 1700 degrees of caloric have been absorbed or carried away from the vicinage, and rendered latent or imperceptible; this heat is returned in a sensible and perceptible form, the moment the vapour is converted once more into water. The general fact is the same in the case of vapour carried off by dry air at any temperature that may be imagined (for down far below the freezing point evaporation proceeds uninterruptedly), or raised into steam by artificial means. The air, heated and dried as it sweeps over the arid surface of the soil, drinks up by day myriads of tons of moisture from the sea—as much indeed as would, were no moisture restored to it, depress its whole expanse at the rate of four feet annually over the surface of the globe. The quantity of heat thus converted from a sensible or perceptible to an insensible or latent state, is almost incredible. The action equally goes on, and with the like results, over the surface of the earth, where there is moisture to be withdrawn, as over that of the sea. But night, and the seasons of the year, come round, and the surplus temperature thus withdrawn and stored away at the time it might have proved superfluous or inconvenient, is reserved, and rendered back so soon as it is required; and the cold of night, and rigor of winter, are modified by the heat given out at the point of condensation, by dew, rain, hail, and snow.

There are, however, cases in which were the process of evaporation to go on without interruption and without limit, that order and regularity might be disturbed which it is the great object of the Creator apparently for an indefinite time to maintain, and the arrangements for equalizing temperature, the equilibrium of saltness, be disturbed in certain portions of the sea, and that of moisture underground in the warmer regions of the earth. To prevent this, checks and counterpoises interpose just as their services come to be required. It could scarcely be imagined that in such of our inland seas as were connected by a narrow strait with the ocean, and were thus cut off from free access to its waters, the supply of fresh water which pours into them from the rivers around, would exactly compensate the amount carried away by evaporation; salt never rises in steam, and it is the pure element alone that it is drawn off. We have in such cases as the Black and Baltic seas an excess of supply over what is required, the surplus in the latter case flowing off through the Dardanelles, in the former through the Great and Little Belts. The vapour withdrawn from the Mediterranean exceeds by about a third the whole amount of fresh water poured into it; the difference is made up by a current through the Straits of Gibraltar in the latter;* and a similar arrangement, modified by circumstances, must exist in all cases where conditions of things are similar,—the supply of water rushing through the strait from the open ocean being in exact proportion to the difference betwixt that provided from rain or by rivers, and that required by the drain of vapour. Seas wholly isolated, such as the Caspian and the Dead Sea, attain in course of time a state of perfect equilibrium—their surface becoming lowered in level and diminished in area, till it comes to be exactly of the proper size to yield in vapour the whole waters

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* Captain Smith's excellent work on the Mediterranean, published since the above was written, throws much valuable light on all these subjects.

poured in. The Dead Sea, before attaining this condition of repose, has sunk thirteen hundred feet below the Mediterranean, the Caspian about one-fourth of this. Lakes originally salt, and which to all appearance are no more than fragments severed from the sea by the earthquake or volcano, and which have no river or rain supplies whatever, in process of time dry up and leave a mass of rock salt in their former basin. Such is the formation in progress in the Lake Assal, in north-eastern Africa, nearly five hundred feet below the level of the sea, its waters having been this much depressed by evaporation, having now almost altogether vanished, one mass of salt remaining in their room. As it is clear in a case such as that of the Mediterranean, that where salt water to a large extent was poured in, and fresh water only was drawn off, a constant concentration of brine must occur, the proposition was laid down by the most distinguished of our geologists, and long held unquestionable, that huge accumulations of salt, in mass larger than all that Cheshire contains, were being formed in its depths. The doctrine, eminently improbable in itself, is now met by the discovery of an outward under current, in all likelihood of brine. It is matter of easy demonstration, that without some such arrangement as this, the Red Sea must long ere now have been converted into one mass of salt, its upper waters at all events being known in reality to differ at present but little in saltness from those of the Southern Ocean. The Red Sea forms an excellent illustration of all kindred cases. Here we have salt water flowing in perpetually through the Straits of Babelmandeb to furnish supplies for a mass of vapour calculated, were the strait shut up, to lower the whole surface of the sea eight feet annually,—and even with the open strait, to add to its contents a proportionate quantity of salt. But an under-current of brine, which, from its gravity, seeks the bottom, flows out again to mingle with the waters of the great Arabian Sea, where, swept along by currents, and raised to the surface by tides and shoals, it is mingled by the waves through the other waters which yearly receiving the enormous monsoon torrents the Concan and the Ghauts supply, become diluted to the proper strength of sea water, and rendered uniform in their constitution, by the agitation of the storms which then prevail. Flowing back again from the coasts of India, where they are now in excess, to those of Africa, where they suffer from perpetual drainage, the same round of operations goes on continually; and the sea, with all its estuaries and its inlets, retains the same limit, and nearly the same constitution, for unnumbered ages. A like check prevents on shore the extreme heating and desiccation from which the ground would otherwise suffer. The earth is a bad conductor of heat; the rays of the sun which enter its surface, and raise the temperature to 100 or 150°, scarcely penetrate a foot into the ground; a little way beneath, the warmth of the soil is nearly the same night and day. The moisture which is there preserved free from the influence of currents of air, is never raised into vapour; so soon as the upper stratum of earth becomes thoroughly dried, capillary action, by means of which all excess of water was withdrawn, ceases; and even under the heats of the tropics, the soil two feet down will be found on the approach of the rains sufficiently moist for the nourishment of plants. The splendid flowers and vigorous foliage which burst forth in May, when the parched soil would lead us to look for nothing but sterility, need in no way surprise us; fountains of water boundless in extent, and limited in depth by the thickness of the soil which contains them have been set aside, and sealed up for their use, beyond the reach of those thirsty winds or burning rays which are suffered only to carry off the liquid which is superfluous and would be pernicious if left, removing it to other lands where its agency is required, or treasuring it up in the crystal vault of the firmament, as the material of clouds and dew,—and the source, when the fitting season comes round again, of those deluges of rain which provide for the wants of the year.

Such are some of the examples which may be supplied of general laws operating over nearly the whole surface of the terraqueous globe. Amongst the local provisions ancillary to these, are the monsoons of India and the land and sea-breezes prevalent throughout the tropical coasts. When a promontory such as that of Hindostan intrudes into the region of the trade-winds, the continuous western current is interrupted, and in its room appear alternating currents from the north-east and south-west, which change their direction as the sun passes the latitude of the place. On the Malabar Coast, as the sun approaches from the southward, clouds and variable winds attend him, and his transit northward is in a week or ten days followed by that furious burst of thunder and tempest which heralds the rainy season. His southward transit is less distinctly marked; it is the sign of approaching fair weather, and is also attended by thunder and storm. The alternating land and sea-breezes are occasioned by the alternate heating and cooling of the soil, the temperature of the sea remaining nearly uniform. At present, when most powerfully felt, the earth by noon will often be found to have attained a temperature of 120°, while the sea rarely rises above 80°. The air, heated and expanded, of course ascends, and draws from the sea a fresh supply to fill its room; the current thus generated constitutes the breeze. During the night the earth often sinks to a temperature of 50° or 60°, cooling the conterminous air, and condensing in the form of dew, the moisture floating around. The sea is now from 15° to 20° warmer than the earth,—the greatest difference between the two existing at sunrise; and in then rushes the air, and draws off a current from the shore.

We have not noticed the Tides, which, obedient to the sun and moon, daily convey two vast masses of water round the globe, and which twice a month, rising to an unusual height, visit elevations which otherwise are dry. During one-half of the year the highest tides visit us by day the other half by night: and at Bombay, at springs, the depths of the two differ by two or three feet from each other. The tides simply rise and fall in the open ocean, to an elevation of two or three feet in all; along our shores, and up gulfs and estuaries, they sweep with the violence of a torrent, having a general range of ten or twelve feet,—sometimes, as at Fundy in America, at Brest and Milford Haven in Europe, to a height of from forty to sixty feet. They sweep our shores from filth, and purify our rivers and inlets, affording to the residents of our islands and continents the benefit of a bi-diurnal ablution, and giving health and freshness and purity wherever they appear. Obedient to the influences of bodies many millions of miles removed from them, their subjection is not the less complete; the vast volume of water, capable of crushing by its weight the most stupendous barriers that can be opposed to it, and bearing on its bosom the navies of the world, impetuously rushing against our shores, gently stops at a given line, and flows back again to its place when the word goes forth—"thus far shalt thou go, and no farther;" and that which no human power or contrivance could have repelled, returns at its appointed time so regularly and surely, that the hour of its approach, and measure of its mass, may be predicted with unerring certainty centuries beforehand. The hurricanes which whirl with such fearful violence over the surface, raising the waters of the sea to enormous elevations, and submerging coasts and islands,—attended as they are by the fearful attributes of thunder and deluges of rain,—seem requisite to deflagrate the noxious gases which have accumulated—to commingle in one healthful mass the polluted elements of the air, and restore it fitted for the ends designed for it. It is with the ordinary, not with the exceptional, operations we have at present to deal, and the laws which rule the hurricane form themselves the subject of a treatise.

We have hitherto dealt with the sea and air,—the one the medium through which the commerce of all nations is transported, the other the means by which it is moved along,—as themselves the great vehicles of moisture, heat, and cold, throughout the regions of the world—the means of securing the interchange of these inestimable commodities, so that excess may be removed to where deficiency exists, deficiency substituted for excess, to the unbounded advantage of all. We have selected this group of illustrations for our views, because they are the most obvious, the most simple, and the most intelligible and beautiful, that could be chosen. Short as our space is, and largely as it has already been trenched upon, we must not confine ourselves to these.

We have already said that the atmosphere forms a spherical shell surrounding the earth to a depth which is unknown to us by reason of its growing tenuity, as it is released from the pressure of its own superincumbent mass. Its upper surface cannot be nearer to us than fifty, and can scarcely be more remote than five hundred miles. It surrounds us on all sides, yet we see it not: it presses on us with a load of fifteen pounds on every square inch of surface of our bodies, or from seventy to one hundred tons on us all, yet we do not so much as feel its weight. Softer than the finest down—more impalpable than the finest gossamer,—it leaves the cobweb undisturbed, and scarcely stirs the slightest flower that feeds on the dew it supplies; yet it bears the fleets of nations on its wings around the world, and crushes the most refractory substances with its weight. When in motion, its force is sufficient to level the most stately forests and stable buildings with the earth—to raise the waters of the ocean into ridges like mountains, and dash the strongest ships to pieces like toys. It warms and cools by turns the earth and the living creatures that inhabit it. It draws up vapours from the sea and land, retains them dissolved in itself or suspended in cisterns of clouds, and throws them down again as rain or dew when they are required. It bends the rays of the sun from their path to give us the twilight of evening and of dawn—it disperses and refracts their various tints to beautify the approach and the retreat of the orb of day. But for the atmosphere, sunshine would burst on us and fail us at once—and at once remove us from midnight darkness to the blaze of noon. We should have no twilight to soften and beautify the landscape—no clouds to shade us from the scorching heat,—but the bald earth as it revolved on its axis would turn its tanned and weathered front to the full and unmitigated rays of the lord of day. It affords the gas which vivifies and warms our frames, and receives into itself that which had been polluted by use, and is thrown off as noxious. It feeds the flame of life exactly as it does that of the fire—it is in both cases consumed, and affords the food of consumption—in both cases it becomes combined with charcoal, which requires it for combustion, and is removed by it when this is over. "It is only the girdling encircling air," says a writer in the *North British Review*, "that flows above and around all, that makes the whole world kin. The carbonic acid with which to-day our breathing fills the air, to-morrow seeks its way round the world. The date-trees that grow round the falls of the Nile will drink it in by their leaves; the cedars of Lebanon will take of it to add to their stature; the cocoa-nuts of Tahiti will grow rapidly upon it; and the palms and bananas of Japan will change it into flowers. The oxygen we are breathing was distilled for us some short time ago by the magnolias of Susquehama, and the great trees that skirt the Orinoco and the Amazon—the giant rhododendrons of the Himalayas contributed to it, and the roses and myrtles of Cashmere, the cinnamon tree of Ceylon, and the forests older than the flood, buried deep in the heart of Africa far behind the Mountains of the Moon. The rain we see descending was thawed for us out of the icebergs which have watched the Polar star for ages; and the lotus lilies have soaked up from the Nile and exhaled as vapour snows that rested on the summits of the Alps." "The atmosphere," says Maun, "which forms the outer surface of the habitable world, is a vast reservoir, into which the supply of food designed for living creatures is thrown,—or, in one word, it is itself the food in its simple form of all living creatures. The animal grinds down the fibre and the tissue of the plant, or the nutritious store that has been laid up within its cells, and converts these into the substance of which its own organs are composed. The plant acquires the organs and nutritious store thus yielded up as food to the animal, from the invulnerable air surrounding it." But animals are furnished with the means of locomotion and of seizure—they can approach their food, and lay hold of and swallow it; plants must await till their food comes to them. No solid particles find access to their frames; the restless ambient air, which rushes past them loaded with the carbon, the hydrogen, the oxygen, the water—everything they need in shape of supplies,—is constantly at hand to minister to their wants, not only to afford them food in due season, but in the shape and fashion in which alone it can avail them.

On the Paragenetic Relations of Minerals.

(Continued from page 152.)

X. *Antimony Formation.*—The principal, and, for the most part, sole representative of this formation, is antimonite. With regard to the periods of formation, of which there may be several, it may be regarded as certain that it is more recent than the argentiferous and auriferous quartz, and anterior to the fluo-barytic formations. It is indeed stated to occur likewise in the clinoedritic formation. Its bedding is quartz, rarely ever absent.

It is a remarkable circumstance that antimonite has always been found to contain at least a trace of gold. In some localities the proportion is sufficiently large for extraction, and even metallic gold is sometimes associated with it. The antimonial minerals by which it is accompanied are kermes, zundererz, berthierite, zinkenite, plagionite, wolfsbergite, &c. Galena and blende are likewise associated with it sometimes. Barytite occurs frequently implanted.

The lodes at Wolfsberg (Harz) probably present the greatest variety of constituent minerals, but scarcely anything is known of their order of succession.

XI. *Manganese and Iron Formation.*—Hematite, specular iron, and more rarely common brown hematite, are frequently associated with the manganese oxides, especially pyrolusite, which is pseudomorphous, partly after manganite, partly but less frequently after polianite. In some instances the manganite and polianite have been found in their normal state. In addition to these occur psilomelan, more rarely braurite and hausmannite. The pseudomorphs after all of these minerals are very numerous. At Laisa (Hesse Darmstadt) there occurs very fine pseudomorphous pyrolusite after manganite; and it would appear that in some instances psilomelan has been converted into pyrolusite, and that the manganese in black, reniform masses, compact and without lustre in the interior, are of this nature.

In Saxony the association of iron and manganese oxides appears to indicate that the former were first precipitated.

The iron oxides then contain at least traces of manganese, while the manganese oxides are free from iron. This fact is in accordance with the chemical fact, that when a solution of iron and manganese peroxides is treated with ammonia, the iron is first precipitated. However, at the Thuringer wald, hematite appears to follow manganese oxides, but this may be connected, in some manner, with the subsequent dislocations which the lodes have suffered.

There are many lodes in which iron oxides or manganese oxides occur separately. They appear in Saxony to be identical with amethyst lodes, in which manganese or iron oxides occur.

This formation is closely connected with barytite, and it is known that baryta is present in most ores of manganese. However, the barytite is always implanted upon the manganese, and for this reason it will be treated of in the next section. Barytite has been observed implanted upon hematite, which occurs, on the other hand, above fluorite and calcite, as do manganese oxides above calcite, although indeed the former presence of these spathic minerals may only be indicated by pseudomorphs. The paragenesis of manganese oxides with calcite is remarkable. Pyrolusite and varvicite, which have originated from manganite, occur pseudomorphous after calcite, the apices of the scalenoedrous still consisting of calcite, and the metamorphosis may easily be seen to have originated from the saalbands.

It would seem that this formation belongs to nearly, if not the same period as the fluo-barytic, barytite appearing as the latest member; but a closer acquaintance with the formation must decide this point.

The most recent rock in which the manganese and iron formation occurs is phonolite.

The general peculiarities of the lodes of this formation are as follow:—

1. Sulphurets are almost altogether absent.

2. Pseudomorphs are more numerous here than in any other formation. It may without exaggeration be said that there is not any manganese lode in which at least one kind of metamorphosis has not taken place. The majority of

manganese minerals are pseudomorphous, and the iron minerals are likewise rich in pseudomorphs.

3. A certain simplicity in the substances contained in these lodes is obvious. The reason has yet to be ascertained why the more valuable metals are almost altogether wanting, and why the lodes of other formations are poor in ore in the neighbourhood of manganese iron lodes, as at Johanngeorgenstadt; and there is reason to believe that an examination of this phenomenon would lead to interesting results.

XII. *Fluo-barytic Formation.*—This formation, when considered in conjunction with the minerals imbedded in it, is certainly inferior to none in either technical or scientific interest. For convenience sake, it will be better to overlook at first the occurrence in it of useful ores, a proceeding which is also justified by the fact, that many lodes of considerable magnitude belonging to this formation are known, in which no traces of either of those minerals have been found.

The great distribution of the minerals constituting this formation becomes more strikingly apparent, when it is remembered that they are found here and there, covering most of the formations previously mentioned, and that they serve as support for five of the following formations. It might indeed be advantageous to class all the known lode formations as, 1, Those older than the fluo-barytic; 2, Those contemporaneous with; and 3, Those which are more recent than it.

The two most important minerals of this formation are, as its name indicates, fluorite and barytite. In most of the lodes of this formation they may be regarded as constant associates. However they do occur apart, and this is true more especially of the barytite.

The largest known lode of fluorite is that at Liebenstein (Meiningen), called the Flossberg, and traversing zechstein. Barytite lodes are often very large, for instance in Saxony, and likewise very numerous. Müller enumerates 1052 known in the Erzgebirge through mining operations, and probably this number is insignificant compared with that of the lodes which are unknown.

In some instances cœlestine occurs together with barytite, or as its substitute.

Among the carbonites belonging to this formation may be named, as most important, pearl-spar, the lightest of the so-called brown spars, and tautokin, characterised by its far greater density. It is much to be desired that these two minerals, so interesting as regards the geognosy of lodes, should be examined chemically. The analyses of brown spars are indeed numerous, but in the absence of data for the angles and densities, they are comparatively valueless to the mineralogist. When associated with barytite, the former of these minerals is seated under, the latter upon it. Chalybite and some varieties of calcite are likewise frequent associates. On the contrary, witherite, strontite, alstonite, barytocalcite, and neotype occur but rarely, and only in particular limited localities. Pinguite, chloropal, and hyposiderite, must be regarded as altogether sporadic, and rare productions of recent date.

Quartz again is frequent, partly as the bedding of the formation, more frequently as a subsequent production; in the latter case constituting a large number of pseudomorphs.

Even the barytite presents, although rarely, impressions of crystalline minerals immediately antecedent to it, shewing that the formation of barytite was here and there connected with the destruction of previously existing minerals.

Fluorite and barytite have been decomposed even still more frequently. These two minerals, and likewise the implanted calcite, have been removed, particularly during and still more after the formation of the more recent quartz. Hence originate the extremely numerous quartz and hornstone pseudomorphs after those minerals. They are partly incrustation, partly replacement pseudomorphs, sometimes both. The numerous tabular impressions in the quartz and galena of Andreasberg (Harz) shew clearly that barytite once existed there in great quantity, although at the present time not a particle is to be found, and baryta occurs there only in the hornstone of the more recent zeolite formation. In the Kurpring Friedrich August mine at Freiberg, the barytite has partially disappeared, and pseudomorphous quartz occupies its place. Witherite produced by the alteration of barytite, is of rare occurrence, and in all probability owed its origin, like the aphrite produced from gypsum, to streams of carbonic acid.

In no other formation are repetitions of the same constituents so numerous as in this; three or four are frequent, and in the Reicher Seegen mine at Sachsenburg, pearl-spar, barytite, and tautoklin, are repeated at one place twenty-two times, without a vestige of ore.

The minerals occurring in the fluo-barytic lodes will be considered under the head of the following formations, with the exception of the iron pyrites, because here this mineral, whether alone or associated with others, always presents a characteristic chemical feature—it is arseniferous. It is highly probable that iron pyrites very generally contains arsenic, although in too small a proportion to be easily recognised. Fritzsche likewise found in the pyrites of this formation, cobalt and nickel to the amount of 1 per cent. On the contrary, pyrites occurring imbedded or disseminated in slate and other rocks, gave no indications of arsenic. Even iron pyrites locally implanted upon arsenical pyrites in old formations gave no sign of arsenic.

The question of the origin of the barytite contained in the lodes naturally suggests itself. When it is remembered that this mineral is almost always accompanied by sulphurets and arseniurets, which can only have been derived from the interior of the earth, we perhaps cannot do otherwise than assume that its source was the same. But in what state? Certainly not as a melted mass, scarcely as an aqueous solution. Professor Breithaupt is disposed to consider that it was introduced into the lodes as sulphuret of barium, and subsequently oxidised, and believes the probability that the interior of the earth consists chiefly of metallic sulphurets to be a sufficient ground for this opinion.

XIII. *Later Cobalt and Nickel Formation, Group A.*—The constituents of this formation at Schladming (Styria), and Oberwallis (Switzerland), are—1. The variety of rothnickelkies, whose specific gravity is 7·3, always containing a small percentage of sulphur, and probably constituting a distinct species. 2. That variety of nickel-glance called gersdorfite or stirian. True spiescobalt, metallic arsenic, and even arsenical pyrites, are said to occur at Schladming. If the latter mineral is really present, it may perhaps indicate that the lode is of very remote date. Calcite is a recent member.

Judging from the little known of a cobalt and nickel formation in the Pyrenees, it is not improbable that it should be included under this group.

Group B occurs principally in the Saxon Voigtland, the Harz, Nassau, Hungary, and Missouri. It is principally imbedded in spathic iron, and can scarcely be regarded as other than sporadic. Nickel is more abundant than cobalt.

The lodes of this group present in a marked manner the peculiar characters of these deposits; their saalbands intersect the rock, especially when it has a schistose structure. The principal minerals are linneite and the less dense varieties of nickel-glance, amoibite, and gray nickelkies. Although galena is sometimes found, the other members of the pyritic formation—zinc-blende and arsenical pyrites—are entirely absent.

With regard to the succession of pyritic arseniurets and sulphurets in general, the same uniformity obtains, which is more prominent in the third group of this formation.

1. The mono-arseniurets have been formed prior to the binarseniurets, and it has already been pointed out that this is the case with sulphurets.

2. The arseniurets have been formed before the sulphurets.

Group C.—Perhaps the purest cobalt minerals occur at Schneeberg and Allemont; at other places nickel minerals preponderate; and probably there is in general a greater quantity of nickel than of cobalt. The association of minerals containing gold and silver may serve to characterize this group.

Spathic iron seldom occurs as the bedding; and when it does there is an approximation to the previous group. Barytite is particularly characteristic, although sometimes its existence is only indicated by pseudomorphs, it having been removed during, or rather after, the subsequent formation of quartz. This quartz contains traces of cobalt. It may in general be assumed that the more abundant the later quartz above heavy spar, the more the latter has been removed.

Still the bedding of heavy spar is not always wanting, even at Schneeberg, and then the auriferous and argentiferous minerals are generally associated with it. Calcite has likewise frequently been decomposed during the formation of quartz, which is often pseudomorphous after it, and these pseudomorphs sometimes present regular twins, in which one primary rhombohedron of quartz is joined parallel to the plane $-\frac{1}{2}$ R of the calcite crystal.

Moreover, the lode quartz in this formation is always different from the rock quartz,—the latter having a fatty, the former a vitreous lustre; sometimes also being in the form of amethyst. The presence of quartz older than barytite, as well as the association of quartz in general, distinguishes this group from the previous and following group, from which quartz is entirely absent.

Group D.—Although very little is known of the occurrence of cobalt and nickel in the rocks of the coal formation, it still appears desirable to call attention to the fact. Cotta states that at the Regenberg (Gotha) asbolan occurs in lodes in carboniferous sandstone, so frequently as to admit of being worked advantageously.

At Bockwa (Saxony) there was found, a few years since, upon small lodes in the upper pitch coal-seams, erythrine, —a mineral which must always be regarded as a product of decomposition; and as iron pyrites, copper pyrites, galena, and zinc-blende, likewise occur in lode fissures of the coal-seams of Saxony, it is very probable that this erythrine has originated from some pyritic mineral containing an essential admixture of cobalt and arsenic. However insignificant this phenomenon may be, it nevertheless gives a hint as to the date of the formation in question.

Group E.—The lodes belonging to this group are situated in cupreous slate, and the overlying members of the zechstein. If greywacke, clay-slate, or granite, lie immediately under the zechstein, cupreous slate and old red sandstone being wanting, the lodes continue productive, although to an inconsiderable distance, in the older rocks. When the lodes bear barytite, they extend to some depth, but are unproductive. They do not bear ore either in the old red sandstone or the schistose rocks, except when covered by the zechstein.

It may perhaps be assumed that a sudden eruption of substances containing metals, especially copper, took place in the sea from which the cupreous slate and other members of the zechstein were deposited, and undoubtedly from lode fissures. The contorted position of the fish in the cupreous slate is a sufficient evidence of their sudden death. A similar opinion was already entertained by Werner; but the metallic substances with which the sea was impregnated were not precipitated at once, and probably not entirely until the formation of zechstein was completed. In several parts of this series—for instance, at the south-western Rothenberge—to nearly 150 feet above the cupreous slate, nodules, and disseminated masses of copper pyrites, are found, which have been partially converted into malachite and brown iron ochre. If, then, cupreous slate is of sedimentary origin, still the copper, silver, and other metals present in it, have been derived from eruptions through lode fissures. If there were any clue to these lodes, it is probable that they will be found to yield rich supplies of ore.

The true primitive cobalt and nickel minerals usually occur in lodes called "rücken," because they are almost always connected with elevation or depression of the sedimentary rocks, partly in cupreous slate alone or in weissliegenden, or when it and the old red sandstone are wanting, somewhat lower down in the slate rocks; partly, but generally only for short distances, in the upper zechstein. The vertical height of the lodes is consequently in many cases very limited. Although, in some districts where this formation exists, the occurrence of the minerals above the cupreous slate is unknown, it is certainly the case near Saalfeld. But under all circumstances, where the lodes are continued in the rothliegenden or schistose rocks, they are wholly unproductive where the covering of zechstein is wanting.

Although no true cobalt or nickel minerals are found even in cupreous slate, when it has no "rücken," still there is at Saalfeld, sometimes in the delicate fissures parallel to the planes of stratification, a coating of erythrine, together with malachite and chessylite; moreover, cobalt has been detected by analysis as one among the numerous ingredients of this slate. Vanadium has likewise been met with recently in the Mansfeld slags; it has probably originated from some cupreous mineral, in which it existed as a substitute of antimony or arsenic.

Friesleben expressly states that cobalt and nickel minerals occur less in cupreous slate itself than in the rücken,—*i.e.* in the lodes traversing it, or when actually in the slate, in the immediate proximity of these rücken.

All these circumstances render it probable that the contents of the lodes called "rücken" have been formed by lateral secretion, the more so as they do not extend downward to any depth. A direct ascension is thus out of the question here. Quartz would, in such a case, have been brought up from the granite and greywacke slate, but there is no trace of quartz or of silicates. It is not improbable that the carbonaceous matter of the cupreous slate has chiefly contributed, by reduction, to the formation of the pyritic minerals, containing also cobalt, nickel, and arsenic.

Asbolan, or black erdcobalt, is one of the minerals which contains cobalt with traces of nickel. This occurs in the lodes above the cupreous slate; in zechstein, which is especially rich in hydrated oxide of iron; indeed, the lodes which bear it do not even extend into the cupreous slate, and appear to be fissures formed by drying, with which zechstein abounds. It has been found by experience that the asbolan near Saalfeld decreases as the cupreous slate is approached. The stalactitic form, and the considerable percentage of water in asbolan, may perhaps be evidence in favour of its being an infiltration product. The large quantity of manganese in asbolan may be accounted for by the fact, that the spathic iron, from which the hydrated oxide of iron has principally originated, contains manganese.

As might be expected, the group in question of the cobalt nickel formation, is not deficient in the associates of cupreous minerals. In the Mansfeld district they are not very abundant on the rücken in cupreous slate and wiesliegenden, still copper glance occurs, and as a rarity, digenite. At Saalfeld the cupreous minerals occur in the lodes, especially above the cupreous slate, and even when this is absent; because, as has been stated, the beds of zechstein are partially impregnated with cupreous minerals; rich deposits of fahlerz, copper pyrites, and barytite, together with the numerous products of these minerals, have been found here in zechstein. The fahlerz generally contains cobalt, a fact which accounts for the efflorescence of erythrine from it; the most usual derivative is, however, the so-called ferruginous copper green. Erythrine has been found upon fahlerz, and indeed upon the crystal planes, where they appear somewhat decomposed, without any other mineral containing cobalt being visible among its associates. Such fahlerz contains even some arsenic. Still it is stated that rothnickelkies and spiess-cobalt have been met with in lodes at a considerable elevation above the cupreous slate. But all the minerals with a metallic lustre here mentioned are known to occur at Saalfeld in lodes, in cupreous slate, or immediately beneath it, the latter especially at Kaulsdorf.

According to Friesleben the cupreous slate, especially at Mansfeld, appears to be richer near the rücken rather than otherwise. This fact may be regarded as a further proof that the metallic substances have generally accumulated towards the rücken.

Barytite as a lode substance, is a very constant associate at all depths; but it is remarkable that it is always more recent than the fahlerz, and older than the pyritic minerals containing cobalt and nickel. For this reason, perhaps, the fahlerz is wanting in the rücken of copper—slate, and weissliegenden, heavy spar being there the oldest member. Calcspar and arragonite appear as more recent members, and it is only in some few instances that there is a second generation of copper pyrites, almost solely in very small crystals upon the calc-spar. In the immense and long-worked deposits of brown iron ore at Könitz, Kamsdorf, and Saalfeld, which belong to the zechstein, and have, perhaps, entirely originated from spathic iron, as is indicated by the frequent pseudomorphs, and the association of compact and frothy wad—the usually accessory derivatives of this mineral,—barytite is, in all instances, more recent than spathic iron or brown iron ore, and lies in numerous veins in them.

The fahlerz and copper pyrites belong only or principally to lodes in zechstein above the cupreous slate, and the fahlerz has most likely not often been found without a covering of heavy spar. Here, as in all other formations, it has been found that it is richer in silver when accompanied by little or no copper pyrites. The galena, which occurs very rarely indeed, may perhaps be referred to the same date as the fahlerz. If, then, the barytite is taken as the boundary, two formations must be distinguished in the lodes,—that of fahlerz and that of cobalt and nickel minerals, even although they may be very closely connected. This distinction is supported by the circumstance that barytite has not been deposited upon the first formation until after the fahlerz has suffered decomposition. Consequently, the constituents of the fahlerz must have first been set in motion, and those of the cobalt and nickel minerals afterwards.

Sometimes the minerals whose formation has preceded that of the barytite are mixed up together with those which have been formed subsequently, partly in a fractured state, and even so-called spheroidal masses are found; phenomena which undoubtedly indicate violent disturbances of the lodes. At the Neidhammeler-zuge, near Saalfeld, fragments of ferruginous zechstein are surrounded by fahlerz, copper pyrites, barytite, and then the numerous decomposition products, ferruginous copper green, copper lazure, malachite, erythrine, kupferschaum, &c. Yellow and brown earthy cobalt and copper—manganese ore likewise occur here,—and these originated either from the hardening of mud, or are decomposition products,—and ochery hydrated oxide of iron, impregnated with oxide of cobalt. Even metallic copper has in some rare instances been found in spike-shaped distorted crystals, entirely surrounded by brown iron ochre.

In the rücken of Schweina and Glücksbrunn spies cobalt is the only abundant primitive mineral of the cobalt nickel formation; rothnickelkies with chloanthite is rare. Bismuth appears to be entirely wanting. The lodes, moreover, bear ore only to the depth of a few yards, corresponding to the thickness of the cupreous slate, and the weissliegenden. In the rothliegenden and in granite they terminate abruptly. (This is likewise the case in the rücken of Sangerhausen and Rothenburg, where rothnickelkies and nickel-glance predominate almost to the entire exclusion of spies cobalt.) In the Riechelsdorf lodes pyrites containing nickel and cobalt occur in the zechstein above the cupreous slate, although near to it, and extend to a small distance beneath it. Traces of bismuth have also been met with here.

According to previous observation, gold and silver minerals are altogether absent from this formation; still the fahlerz contains as much as ½ per cent. of silver, and although this mineral, strictly speaking, does not belong to this group of the formation which commences with heavy spar, as has been shewn, it has been included because it appears in the same lodes, and because it not unfrequently contains cobalt.

As regards the great variety of minerals occurring in the lodes, the Saalfeld district is the most important.

It must be admitted that these five groups of the cobalt nickel formation cannot be referred to one and the same period, but must, perhaps, be separated into several lode formations. The Chilian is undoubtedly distinct, and should perhaps be placed immediately after the fifth formation. Again, a group which includes lode quartz as an essential constituent should, perhaps, be separated from one in which it is absent. The want of observations respecting the relative age of the individual lodes in which cobalt and nickel minerals occur, the absence of spathic iron, and especially of barytite, or their pseudomorphs, in some places have rendered it necessary to consider under one head groups of minerals which will, without doubt, hereafter be found to differ. Still the course here adopted has the advantage of presenting a connected view of the known modes of occurrence of bodies which in a mineralogical, chemical, and geognostical point of view are very closely related.

Further, the localities enumerated admit of the conclusion being drawn, that the most recent group belongs to a period between the completion of the old coal formation, and but little subsequent to the zechstein; up to the present time at least, it is not known that cobalt or nickel minerals occur in a sedimentary formation more recent than the latter.

XIV. *Barytic, Lead, and Zinc Formation.*—Although this formation is characterised as barytic, the most frequent lodic substance next to barytite is fluorspar. The lodes may in other respects be classified into two groups, according to the presence or absence of quartz.

Among the minerals galena is the most characteristic. It is generally poor in silver, in some rarer instances without any. There is perhaps no other formation of which it is an essential member where it has suffered so many alterations. The most ordinary products of decomposition are cerussite, hyromorphite, mimetite, anglesite, leadhilite, phosgenite, mendipite, plumbocalcite, and the very rare schwebleinz (superoxide of lead).

(*To be concluded in our next Number.*)

On the Fossil Plants found in Amber. By Professor GOEPPERT.

[Berlin Academy, Bulletin, 1853, pp. 450–476; and Leonhard u. Bronn's N. Jahrb. f. Min. u.s.w. 1853, pp. 745–749.]

Since Prof. Goeppert recognised the *Taxodites dubius* of Sternberg, which occurs abundantly in the plant-bed at Schosnitz, Silesia, as the *Taxodium distichum*, Rich., now living in the southern parts of the United States and in Mexico, and found also some fossil Plants from Schosnitz to be identical with living species, thus pointing out the identity of some tertiary plants with the living, he has had the opportunity of examining a collection of 570 specimens of Amber, containing plant-remains, belonging to M. Menge of Dantzig, and 30 specimens bequeathed by M. Berendt. With these the author has been enabled to raise the number of the species of plants in the Amber Flora from 44 to 163, of which only *Libocedrites salicornioides* and *Taxodites Europæus* occur fossil out of the Amber, and 30 are identical with existing species. The constitution of the Amber Flora, as at present known, is shewn in the following table.*

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* For the lists of genera and species, see the works above referred to.

		Number of Species.	Number identical with existing Species.
	PLANTÆ CELLULARES.		
I.	Fungi	16	4, certainly; perhaps all.
II.	Algæ	1	1
III.	Lichenes	12	6 or 7 (with species on the E. and W. coasts of Arctic America.)
IV.	Musci hepatici: Jungermannieæ } 39 specimens	11	11
V.	Musci frondosi	19	2 or 3, certainly; perhaps all.
	PLANTÆ VASCULARES.		
III.	Cryptogamæ (Acotyledones.)		
	Filices.		
	Pecopteris Humboldtana, *Göpp. & Behr.*		
IV.	Monocotyledones.		
	Cyperaceæ.		
	Carex eximia, *Göpp. and Menge.*		
	Gramineæ.		
	Fragments.		
	Alismaceæ.		
	Alisma plantaginoides, *Göpp. & Menge.*		
V.	Gymnospermæ.		
	Cupressineæ	20	2
	Abietineæ	31*	1
	Gnetaceæ	1	
VI.	Monochlamydeæ.		
	Betulaceæ	2	
	Cupuliferæ	10	
	Salicineæ	3	
VII.	Corollifloræ.		
	Ericineæ	22	3
	Vaccineæ	1	
	Primulaceæ	2	
	Verbasceæ	2	1
	Solaneæ	1	
	Scrophularineæ	1	
	Lonicereæ	1	
VIII.	Choristopetalæ.		
	Lorantheæ		
	Crassulaceæ	1	1

The whole Flora as yet known consists of 24 Families, 64 Genera; comprising 163 species.†

The following are the general results of Prof. Goeppert's researches.

A considerable number of tertiary species of plants (especially *Plantæ cellulares*) are still living.

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* Of these, eight (the species determined from the fossil wood) afford Amber.

† The number of species may probably be raised to about 180, by additions from about 50 specimens of which the relations are barely determinable.

The flora of the Amber being destitute of tropical and sub-tropical forms, it is to be referred to the Pliocene period.

The remains only of forest-plants have been preserved in the Amber.

This flora much resembles the present, especially in the Cellular plants; the *Cupressineæ*, however, are now almost wholly wanting in our latitudes, and the *Abietineæ* and the *Ericineæ* are not abundant. The four species, of *Thuia*, *Andromeda*, and *Sedum*, which are identical with the living, are indeed northern forms; on the other hand, the *Libocedrus Chilensis* is found on the Andes of Southern Chili.

The flora of the northern parts of Europe, Asia, and America, is at present less rich in species of *Cupressineæ* and *Abietineæ* than that of the Amber, although it possesses some of the species found in the latter; nor are the existing northern species of *Coniferæ* so rich in resinous products as were the trees of the Amber-flora with which the *Dammara Australis* of New Zealand can alone in this respect be compared, the branches and twigs of this tree being stiff with white resin-drops.

If we take into consideration the enormous extent which the forests of

Abies alba,	Abies ovata,
—— nigra,	Larix Dahurica,
—— balsamea,	—— Sibirica, and
—— Sibirica,	Pinus Cembra,

at present attain in North America and Northern Asia, we are led to infer a similar extension in former times of the Amber-forests throughout the northern regions; to which, indeed, the wide distribution of amber in the late tertiary deposits of North America, Holland, North Germany, Russia, and Siberia to Kamtschatka, bears evidence.

If we judge from the proportion which the fir-forests bear to the rest of our northern flora generally, we shall infer, from the prevalence of the *Coniferæ* in the Amber, the existence of a very rich flora contemporaneous with the latter, and of which but a small part has as yet been presented to our notice. Germany contains 6800 species of *Cryptogamæ*, according to Rabenhorst, and 3454 species of *Phanerogamæ*, according to Koch. The proportions are—

	The German Flora.			The Amber Flor[a].		
	Classes.	Species.		Classes.	Speci[es].	
Cryptogamæ	8	6800	......	6	60	
	Families.	Species.		Families.	Species.	
Phanerogamæ	135	3454	......	20	102	
Cupuliferæ	...	12	......	...	10	
Ericineæ	...	23	......	...	24	
Proportion of trees and plants	{333 / 3121}	= 1 : 10	...	{94 / 9}	= 10 : 1	

Amber is never found isolated in large or small masses in the bituminous wood of the Brown-coal with resin-ducts of a single row of cells, which never contain yellow masses of resin, but only dark-brown transparent resin-drops, as in the *Cupressineæ*, or the *Cupressinoxylon* of Goeppert. The compound resin-ducts of the *Abietineæ* alone are filled with amber.

It is probable that the amber and its plant-remains have been drifted to the places in which they are now found. The author knows of no well-authenticated instance of the occurrence of amber in the Brown-coal formation itself; it occurs in the drift-beds above it, where, however, it does not appear to have originally belonged. Scheerer has found it in Norway; Von Brevern, atG ischiginsk in Kamtschatka; Rink, in Haven Island, near Disco Island, Greenland; and in these instances it is generally in drift-beds. The supposition, however, that it belongs to the Drift-period is difficult to substantiate, the flora of that period being as yet but little known. The stomach of the fossil Mastodon found in New Jersey contained twigs of *Thuja occidentalis* (found in the Amber-flora); and in the Erie Canal, in New York State, at a depth of 118 feet there have been found freshwater shells, together with portions of *Abies Canadensis*, which still grows in the neighbourhood, and leaves of which are recognised (though with some doubt) in the amber. The fossil wood of the Drift-beds of Siberia, also, is nearly related to that of the present day.*

The height at which amber is found at the Castle on the Riesengebirge near Helmsdorf is nearly 1250 feet [German] above the sea level, and at Grossman's Factory near Tannhausen, at 1350 feet.

The amber is not derived from one species of wood only (*Pinites succinifer*), as Professor Goeppert formerly thought, but also from eight other species, including the *Pinus Rinkianus*, in which Vaupelt observed the amber of Disco Island.

It is probable that all the *Abietinæ*, and perhaps the *Cupressineæ*, have furnished their share of the resinous matter (at first consisting of various specifically different resins) that afterwards by fossilization became amber; and this is supported by the author's experiments in the formation of amber from resin by the wet process, as in his experiments on the formation of coal from recent plants.†

In form the amber is either like drops, indicative of a former semi-fluid condition, or as the casts of resin-ducts and cavities. Large nodular masses occur, which must have been accumulated in the lower part of the stem or the root, as in the Copal trees.—(*Quarterly Journal of the Geological Society*, vol. x., No. 37.)

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* See Quart. Journ. Geol. Soc., vol. vi. Part 2. Miscell. p. 66.—Transl.

† Ibid., p. 33.—Transl.

SCIENTIFIC INTELLIGENCE.

METEOROLOGY.

1. *Climate of Finmarken.*—"I shall here add," says Professor Forbes, "a few particulars which give a general idea of the climate of this part of Norway. For eleven years (1837-48), the average temperature at 9 A.M. was 34°·50; at 9 P.M., 32°·83; mean 33°·66. Von Buch estimated it, solely from the upper level of the Pine (640 feet above the sea), at nearly 1° Reaumur, or 34°·25 Fahrenheit, a remarkable coincidence. The mean temperature of February, which is decidedly the coldest month, is 15°·4; and of August, which is usually the hottest, 54°·3. This range is, however, small, compared with the actual extremes on particular days, which I find to be the following, during three years, for which they are specified; but of which those for 1848 only are certainly taken with self-registering instruments:—

	1846.	1847.	1848.
Maximum	83°·3	84°·7	86°·9
Minimum	14 ·8	3 ·1	20 ·2
Range	98 ·1	87 ·8	107 ·1

Hence it appears that the thermometer rarely, if ever, falls below the zero of Fahrenheit, whilst there is not, perhaps, another part of the earth's surface on this parallel where mercury does not freeze in winter. The fall of rain and snow in these three years was only 18·18, 16·81, and 17·19 inches."*—(*Norway and its Glaciers, by Professor James D. Forbes.*)

2. *Proposed Meteorological Survey.*—We regret to have to announce to the scientific public, on the authority of Captain James, Royal Engineers, that the proposed second conference at Brussels, for making arrangements for the mutual interchanges of the principal results obtained from the meteorological observations taken on land in all parts of the world, cannot, under the present aspect of our foreign relations, take place this year.

The opinions of all the most eminent meteorologists in Europe and America are strongly in favour of such a combination and system of co-operation, and we trust the war which is now pending may be of short duration, and that this conference may still be held at no distant day.

HYDROGRAPHY.

3. *Amount of pressure borne by Animal Life in profound depths.*—The real amount of pressure borne by animal life in profound depths is truly an interesting element for consideration and

* See Reports of British Association for 1849 and following years.

experiment. At 16 fathoms a living creature would have to sustain only about 60 pounds to the square inch, and at 60 fathoms as much as 180 pounds. At 100 fathoms depth the pressure would amount to 285 pounds; and at 700 fathoms the creature must bear with impunity a quantity equal to 1830 pounds upon the square inch; while the pressure of 1000 fathoms of superincumbent water on the same area considerably exceeds a ton.—(*Rear-Admiral Smyth, K.S.F., on the Mediterranean,* p. 193.)

4. *Sea Pressure.*—" In proportion to the descent into the sea does the pressure of the superior portion upon the inferior become greater; and as a column of sea water, 11 yards in height, is nearly of the same weight as a column of air of an equal base, extending from the surface of the earth to the limit of the atmosphere, it follows that, at a depth of 1100 yards, the water sustains a pressure of 100 atmospheres. How enormous, then, must this pressure be on beds still lower, if the mean depth of the sea, at a distance from the coasts, extends for several miles, as the laws of gravitation seem to indicate." A question thence arises as to the depth of water necessary to produce the liquefaction of gases. Estimating the height of a column of water equal to the pressure of an atmosphere, in the usual way, at 34 feet, and neglecting the saline contents of the sea, as well as the probable compression of water itself at vast depths, Dr Faraday has shewn (Philosophical Transactions for 1823) the pressure and temperature at which the gaseous substances below enumerated become liquid in his experiments, and it results that those gases could not exist as such below the depths marked in feet on the last column.

			Feet.
Sulphurous acid gas liquifies, under	2 atmospheres, at	45°	68
Cyanogen gas, ...	3·6 ...	45°	123
Chlorine gas, ...	4 ...	60°	136
Ammoniacal gas, ...	6·5 ...	50°	221
Sulphuretted hydrogen gas,	17 ...	50°	578
Carbonic acid gas, ...	36 ...	32°	1224
Muriatic acid gas, ...	40 ...	50°	1360
Nitrous oxide gas, ...	50 ...	45°	1700

—(*Rear-Admiral W. H. Smyth, K.S.F., on the Mediterranean Sea.*)

5. *The Colour of the Ocean.*—The usual tint of the Mediterranean Sea, when undisturbed by accidental or local causes, is a bright and deep blue; but in the Adriatic a green tinge is prevalent; in the Levant basin it borders on purple, while the Euxine often has the dark aspect from which it derives its modern appellation. The clear ultramarine tint is the most general, and has been immemorially noticed, although the diaphanous translucence of the water almost justifies those who assert that it has no colour at all. Seamen admit of one conclusion in regard to colour, namely, that a green

hue is a general indication of soundings, and indigo blue of profound depth.—(*Rear-Admiral W.H. Smyth, K.S.F., on the Mediterranean Sea*, p. 125.)

6. *Admiral Smyth on the Temperature of the Ocean.*—The result of my experiments leads to the conclusion that there actually exists a very sensible diminution between the surface temperature and that obtained at great depths, and the difference may be roundly estimated at about one degree for every twenty fathoms of line near the surface, save where the agency of subterranean currents may be at work, for such streams are undoubtedly connected with oceanic influences; but below about 180 fathoms, to our utmost depths, the temperature varied but little from 42° or 43° of the Fahrenheit scale. We found that at equal depths the warmth is rather higher along shore than in the offing; still no reliance can be placed here upon thermometrical indications of an approach to land or a great bank, as taught in the Atlantic Ocean, and the supposed heating of the waves is a mistaken sensation produced by the cooling of the atmosphere in the meantime. The mere surface temperature is very variable, according to the weather and the altitude of the sun, differing at sunrise and in the afternoon by three or four degrees, and even more.—(*Rear-Admiral W. H. Smyth, K.S.F., on the Mediterranean Sea*, p. 124.)

7. *Captain Allen's proposal of converting the Dead Sea into a north-eastern extension of the Mediterranean.*—There is certainly no natural feature of the earth's surface more astounding, or more difficult of explanation, than the existence of this long deep fissure, which, being 630 feet below the Mediterranean at the Lake of Tiberias, deepens in the Dead Sea to 1300 feet below the general sea-level. With the nature of the hilly country between the Mediterranean and the Sea of Tiberias we are pretty well acquainted, and we are reminded by Captain Allen that a line of communication might be established without traversing any very high ground. Hence it is possible that the modern spirit of enterprise might adopt the suggestion of a ship canal, as shadowed out by this officer, through which the waters of the Mediterranean, rushing for a number of years, might be cascaded into the low country, and thus submerging a great area, now pestilential and of little or no value, render the Dead Sea a south-eastern extension of the Mediterranean. But still there would remain a space of land to be cut through from the Dead Sea depression into the Red Sea; and the first question is, what is the nature of that barrier, and what its altitude.

But before we can arrive at any explanation of this problem in ancient or geological geography, or form any rational conjecture of the eventual possibility of opening such a water communication between Europe and Southern Asia, it is essential that the true physical features of the region, particularly of the tract between the Dead Sea and the Red Sea, be delineated. For this purpose the proposal of Captain Allen to effect in his own person a survey of such lands, accompanied by a competent officer of the Royal Engineers,* is well worthy of our country, and I hope will be ordered by her Majesty's Government.—(*Sir Roderick Murchison's Address to the Royal Geographical Society*, vol. xxii., p. 15.)

8. *Arctic Glaciers.*—As, doubtless, large portions of our continents were under water when vast erratic blocks were transported to great distances by icebergs and deposited on what are now plains of terra firma, so these must have proceeded from ice-clad continents. Among others, I have laboured with my associates to shew how all the higher portions of Scandinavia and Lapland constituted a glacial centre in a former icy period which sent off its stone-bearing ice vessels to what is now the dry land of Germany, then a sea bottom. Dr Rink now comes out with a demonstration, that in the present period all the vast continent of Greenland, as far as is known, is one vast interior of ice, through which the rocks scarcely protrude, and though of no great altitude, is yet sufficiently high in its central parts to afford a slight incline in the general and onward march for the enormous ice-field, until, protruding its arms into deep and long lateral fronds, huge bergs are in certain favouring spots broken off from the parent mass, and calve (as the Danes term their launch), before they sail away into Davis Straits and southwards.

9. *Alpine, Norwegian, Himalayan, Snowdon, Cambrian, and Highland Glaciers.*—The glaciers which have been observed in the Alps, Norway, and Himalayan mountains, are separate ice streams, which fill valleys, and radiate from certain lofty centres, carrying with them the materials out of which their moraines are formed. And in some of our insular tracts, such as Snowdon and the Cumbrian mountains, we can easily explain how such glaciers must there also have acted from similar centres, and have scratched and polished the shoulders of the valleys as they descended. But as several authors have observed, and as Mr Robert Chambers has well shewn, in a recent memoir,† replete with good new observations on the west coast of the Highlands, there are many lofty tracts in Scotland, as well as in Norway and other countries, Striation seems to be quite independent of the outline of the ground, thus indicating a grand and general movement of ice.

It is to countries which present such phenomena that the memoir of Dr Rink forcibly applies; and it leads us to imagine that there was a period when Scotland, particularly all the Highlands, was ana-

* Steps were taken a few months ago to carry out this project, and General Sir J. Burgoyne, with whom I consulted, was quite prepared to furnish the requisite engineer officer, but the season was considered too far advanced. I trust that the Government will sanction the execution of the enterprise next winter or spring.

† Edin. New Phil. Journal, April 1853, p. 229.

logous to what Greenland now is, and when an icy mantle extended itself from higher plateaux into the fronds or friths on its sides.—(*Sir Roderick Murchison's Address to the Royal Geographical Society*, vol. xxiii., p. lxxxiii.)

10. *Professor Dove on Oceanic Currents.*—The influence of oceanic currents, says the Earl of Rosse, on the temperature of the regions in which they prevail, was very inadequately appreciated before the publication of these researches. Of these currents, the most important, and infinitely the most interesting to ourselves, is that so well-known as the Gulf Stream. Its immense influence in moderating the winter cold along the shores of western Europe, is shewn by the singularly abnormal position of the winter isothermals in that region; and not only is this fact of great interest in itself, and of first-rate importance in meteorology, but it has also enabled the geologist to form a far more accurate estimate than otherwise it would have been possible to have done of the probable climatal influences of particular configurations of land and sea, and thus to overcome, not by arbitrary hypothesis, but by logical deduction, some of the greatest apparent anomalies in speculative geology. The former existence of glaciers in our own islands need no longer be regarded as a mystery, for it is now demonstrable that they would be highly probable, if not absolutely necessary, consequences of any configuration of land and sea, which should divert the Gulf Stream from its present course; and the geologist has no difficulty in conceiving such a configuration, not merely as a possible, but as one which probably did exist during the glacial period. I mention this as an instance of the diffusive influence of a great step in one science on the progress of science either more or less directly associated with it. A further and very important conclusion has been deduced by Professor Dove, from the monthly isothermals; I mean the fact that the mean temperature of the surface of the globe, as a whole, is higher when the sun is in the northern than in the southern signs. The explanation is, that the northern hemisphere has more land than sea at the surface, and the southern much more sea than land, and that from the different action of the sun's rays on the solid and fluid surfaces, it follows that the hot summer of the northern hemisphere, added to the milder winter of the southern, gives a mean of general temperature several degrees of Fahrenheit higher than the cool summer of the southern, together with the cold winter of the northern hemisphere.—(*Proceedings of the Royal Society*, vol. vi. No. 99; *Earl of Rosse's Address at the Anniversary Meeting of the Royal Society, London.*

MINERALOGY.

11. *On the supposed new metal Aridium.*—Some years since Ullgren published a paper upon a substance found by him in a Norwegian chromic iron ore, and which he considered as the oxide of a new metal, closely resembling iron in its chemical properties and relations. Bahr has carefully examined the mineral in question,

and finds that the so-called oxide of aridium is merely oxide of iron, with a little phosphoric acid and oxide of chromium.—(*Journal fur Practische Chemie*, ix. 27.)

12. *Density of Selenium.*—Schaffgotch has determined the density of selenium, and deduces from a great number of experiments the following conclusions :—1*st*, Selenium has two different specific gravities (at 16 R.), namely, 4·282 and 4·801. The smaller number belongs to an amorphous and glassy condition, the higher one to a granular crystalline state; the two states may be converted into each other at pleasure. 2*d*, The blood-red flocky Selenium, as precipitated in the cold, has the density of amorphous Selenium, whether its colour and apparent volume have been changed by heat or not.—(*American Journal of Science and Arts*, 2d series, No. 49, p. 123.)

13. *Dolomite.*—M. J. Durocher has obtained dolomite artificially through the action of magnesia vapours. He put in a gun-barrel some anhydrous chloride of magnesium, and a porous carbonate of lime, the latter being so placed that it could be reached only by vapours from the former. The gun-barrel was closed, and then kept at a low red-heat for three hours. The limestone, when taken out, was partly scoriaceous externally, and covered with a mixture of chloride of calcium, and chloride of magnesium within; it was altered mostly to a dolomite, as ascertained by analysis.—(*American Journal of Science and Arts*, vol. xvii., No. 49, 2d series, p. 128.)

14. *Crystallized Furnace Products.*—F. Sandberger has announced the occurrence, as furnace products, of graphite in 6-sided tables near Dillenburg; metallic copper in threads, and rarely octahedral crystals, near Dillenburg; antimonial nickel in long hexagonal needles, at Ems; galena in cleavable cubes, at Holzappel and Ems; magnetic iron in octahedra; $3\ Cu^2\ O + SbO^3$ in copper red or yellow hexagonal tables, at Dillenburg; $Ti\ Cy + 3\ Ti^3\ N$ in Bodenstein.—(*American Journal of Science and Arts*, vol. xvii., No. 49, 2d series, p. 128.)

15. *Purification of Graphite for Lead Pencils.*—Runge proposes to purify poor graphite for pencils, by digesting, for thirty-six hours, the finely powdered mineral with about double its weight of concentrated sulphuric acid, then diluting the acid with water, and washing the powder free from acid. Graphite thus powdered is very much cheaper than the ordinary English, and is quite as pure as the best Borrowdale black-lead. The decanted sulphuric acid contains iron, sulphate of alumina, &c.; the latter may be separated when large quantities of graphite are operated upon. Runge also proposes to add a little lamp-black with the graphite, in order that the lines made by the pencils may have a deeper shade of black. Probably certain kinds of manganese may be used for the same purpose.—(*La Technologiste*, April 1853, p. 360; *Dublin Journal of Industrial Progress*, No. 1, p. 21.)

16. *Arctic Minerals.*—Before we take leave of arctic subjects, says Sir Roderick Murchison, let me remind you that, judging from a memoir communicated by M. Lundt of Denmark, and lately read to our society by Sir Walter Trevelyan, on the mineral produce of the southern parts of Greenland, we have every reason to think that valuable ores of copper may be found to extend far to the north of the tracts around Disco, where the minerals in question were observed. Judging from the few rocks submitted to my inspection by Captain Inglefield, and which were collected in the more northern parallel of 77°, I should infer, from their crystalline character, that a very large portion of this region may prove to be metalliferous, and that industry may there be rewarded with spoils of the land, as well as by catching the whales and seals of the sea.—(*Sir Roderiek Murchison's Address to the Royal Geographical Society*, vol. xxiii., p. lxxxiii.)

GEOLOGY.

17. *The Lower Silurian Rocks of the United States.*—One of the chief geological facts ascertained in reference to the origin of life in the crust of the globe, is the discovery of certain fossil animals (trilobites) in strata lower than any in which they had been found in America, but which are precisely on the same horizon as the lowest fossil-bearing Silurian rocks of Britain, Scandinavia, Russia, and Bohemia, where trilobites also occur in the same relative position. Excuse me, then, if I say that I felt no small pride when I saw that M. Owen had mapped all these rocks as lower Silurian, and as agreeing with those which, under that name, I have defined to be the lowest fossiliferous rocks of Europe. These and other palæozoic rocks, the equivalents of our Devonian, are surmounted by carboniferous masses of such extent, that one of them may be mentioned as a coal-field larger than England.—(*Sir Roderick Murchison's Address to the Royal Geographical Society.*)

18. *Nature of the Coral-Reefs between the coasts of Florida and Mexico.*—I must, indeed, specially allude to an admirable illustration of the true nature of the coral-reefs between the coasts of Florida and Mexico, the "Keys" of the seamen. In a separate report on the topography of that tract, in relation to the former, present, and probable future condition of such reefs, Professor Agassiz has successfully shewn how all such surveys ought to be made in conjunction with naturalists. For, quite independent of the important additions to natural history knowledge which are obtained, statesmen as well as hydrographers thus ascertain the causes of increase or decrease of coral reefs, and learn that whilst no human power can arrest the growth of such reefs, there are channels amidst them which will remain deep in long periods of time, and the outlines of which, when well defined by lighthouses, may be the salvation of much life and property. In other words, the fixed and stable points, of land and the channels which are dangerous, are

thus accurately defined by the great naturalist Agassiz.—(*Sir Roderick Murchison's Address to the Royal Geographical Society*, vol. xxiii.)

19. *Geological conclusions in regard to the Russian Interior Seas.*—There is perhaps no feature of more commanding interest in its bearing on the physical outlines of the earth at a period which approaches near to our own era, than the fact, which geological researches have established, that there has existed a vast interior sea, which covered all the area between Constantinople on the west, and Turkestan on the east, or a length of nearly two thousand miles, whilst it ranged irregularly from south to north over a space broader than the present Caspian Sea is long, or of about one thousand miles. Of this great submerged area, the Seas of Azof, the Caspian, and the Aral, are now clearly the chief detached remnants. For, as I formerly explained, the very same species of mollusca which are now living in these seas, are found in a fossil state in limestones forming cliffs on their shores, or on those of the Black Sea, or in masses ef intermediate land, which are simply the elevated bottoms of a once continuous vast internal sea, the whole of whose inhabitants were as distinct from those of the then ocean as are the present inhabitants of these detached Caspians from those of the present Mediterranean and ocean.—(*Sir Roderick Murchison's Address to the Royal Geographical Society*, vol. xxiii., p. lxxxvii.)

20. *On the probable depth of the Ocean of the European Chalk Deposits.* By Professor H. D. Rogers (Prov. Bost. Soc. Nat. Hist., 1853, 297.)—Various geologists, and among them Professor Ed. Forbes, in his excellent and learned Palæontology of the British Isles, in Johnston's Physical Atlas, have suggested that the ocean of the chalk deposits of Europe was a deep one; and in evidence of this, Professor Forbes cites the "striking relationship existing to deep sea form of the English Chalk Corals and Brachiopods, adding, that the peculiar Echinoderms (Holaster, alerites, Ananchytes, Cidaris, Brissus, and Goniaster) favour this notion, as also the presence of numerous Foraminifera."

21. *Professor Rogers' objections to Professor Forbes' Deep-Sea Genera.*—I beg leave to present a difficulty in the way of this conclusion. Several of these genera of Echinoderms, as Ananchytes, Cidaris, &c., occur in the greensand deposit of New Jersey, referable by every fossil test to the age of the greensand and chalk of Europe. And this American stratum was unquestionably the sediment of quite shallow littoral waters. That they must have had a trivial depth is proved by the circumstance that they repose in almost horizontal stratification, at a level of not more than from one to two hundred feet lower than the general surface of the hills and upland region to the N.W. of the margin of the zone they occupy as their outcrop. It is obvious that a depression of the cretaceous region, such as would cover the present deposits with a deep sea, would have like-

wise overspread the low gneissic hills to the N.W. of the Delaware, which present no traces of having ever been submerged during the cretaceous or any secondary period.

22. *Mr Ayres' objections to Professor Forbes' Deep-Sea Genera.*—Mr Ayres remarked, that of those genera of Echinoderms, which Mr Forbes regarded as deep-sea genera, two or three are found in North America, in water not two hundred feet deep. Terebratula, which has been generally regarded as only an inhabitant of very deep water, and whose structure has been described as admirably adapted to the depth at which it has been found, and which Professor Owen has demonstrated, cannot exist at a depth of less than two or three hundred fathoms, exists at Eastport, Me., in water so shallow that it can be taken by hand. In the same locality and position, radiata are found, which have heretofore been thought to be only inhabitants of deep water. Some of Professor Forbes' genera are also found in less than ten fathoms of water.—(*American Journal of Science and Art*, vol. xvii., No. 49.)

23. *Artificial Silicification of Limestone.*—It is some years since M. Kuhlmann of Lille proposed to preserve pieces of sculpture, &c., by impregnating them with a solution of silicate of potash—$SiO^3 KO + CO^2 CaO = SiO^3 CaO + CO^2 KO$. This process has been used on a grand scale in certain parts of the cathedral Notre Dame. The architect of the cathedral reports as follows:—1. That the infiltration of silica made " sur les terrasses et contre-fort du chœur," in October 1852, has preserved the stone from the green moss that covers stone in moist places. 2. That the gutters and flagging of limestone subjected to this process present surfaces perfectly dry, covered with a silicious crust. 3. That upon the stone so prepared, dust and spider webs are less common than upon the stone in the ordinary state. The report also states, that tender stones have been rendered hard; they have lost part of their porosity, and after being washed, they dry more rapidly than stones not silicified. The process has succeeded completely on all calcareous blocks, whether isolated, or forming part of the structure, new and old.

It is not yet known how this process will act on mortars; but if successful, the silification of an entire monument may be accomplished, and its restoration when old. The whole exterior might be thus covered with a thick bed of artificial silicate of lime, and a whole edifice be protected by this means from all atmospheric causes of destruction.*—(*American Journal of Science and Arts*, 2d Series, No. 49. January 1854, p. 119.)

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* This process may prove highly useful in protecting the rapid decomposition of some of our finer building stones, that are exposed to much damp. The overseers of our finer buildings ought, undoubtedly, not to overlook this important notice.

24. *To render Sandstone and other porous materials impervious to Water.*—The sandstone is first heated to a temperature of about 400 Fahrenheit, and then plunged into coal tar, heated to about the same temperature, and allowed to remain in it for about eight hours. In this way a mass is obtained so solid, that it is scarcely possible to break it with a hammer. Bricks and tiles require only four hours steeping, at a temperature of about 230° Fahrenheit. (Acid cisterns and refrigerators of Yorkshire sandstone, and many other applications of that material, have been boiled, in this way, in tar, since several years, in many of the chemical factories of Great Britain, and with the best results.)—(*Forster's Bauzeitung*, 1853, p. 35. *The Dublin Monthly Journal of Industrial Progress.* No. 11, p. 55.)

25. *Employment of Quick Lime in High Furnaces, instead of Limestone, by C. Montefior Levi, and Dr Emil Schmidt.*—From experiments made at the iron-works of Ougrée near Liege, they found that to produce 100 kilogrammes of pig-iron, the average consumption of coke for six months of 28 days, when limestone was used, was 160½ kilogrammes; whilst with burned lime the consumption was only 146½ kilogrammes; being a saving of 8·88 per cent. The average production for 28 days with limestone was 461,000 kilogrammes, and with burned lime, 735,000, or an increase of 24·3 per cent. Corresponding results were obtained with another furnace, worked for three months with limestone, and three with burned lime. The average coke consumed per 100 kilogrammes with the former being 162, and with the latter 147¼ kilogrammes; the production of iron per month being on an average 469,000 with limestone, and 563,000 kilogrammes with lime. The furnaces at Ougrée have now been working 3½ years with lime, with the same result; the saving per year, notwithstanding the cost of burning the lime, being 30,000 francs per furnace. The same process has been successfully tried in some parts of Wales, and in England.—(*Zeitschr. des Ostr. Ing. Vereins*, 1852, p. 145.)

26. *Professor Rogers on Earthquake Movements, and the thickness of the Earth's Crust.*—Professor Rogers is of opinion that the undulatory movement of an earthquake is felt much more sensibly at a point above the earth's surface, than directly upon it. An instance illustrating this had come within his own knowledge. The earthquake which destroyed the principal city of Guadaloupe was felt in the city of New York, but only in the fourth story of a printing office. The sound generally precedes the shock, as has been observed in this country. In North America, the undulation is always parallel to the physical features of the continent, making it reasonable to believe, that through a long series of epochs the motion has been in one rather than various directions, as supposed by Elie de Beaumont. There are two movements in earthquakes; an undulatory and a molecular movement. The latter, Professor Rogers

thought, was the movement which attracted most observation, giving rise as it does, to sudden and abrupt changes of relation on the surface of the earth, at places where the formation of the strata admits of more or less freedom of movement, causing the sudden shocks which are so destructive.

Professor Rogers is of opinion, that the thickness of the earth's crust, in most places, is not more than ten miles.—(*American Journal of Science and Art*, vol. xvii., p. 135.)

27. *Coloration.*—Coloration cannot be made use of as a generic character, and its importance to the palæontologist is small, but when occurring on fossil forms it should always be noted. Professor Forbes has kindly informed me, " that his observations on the distribution in depth of recent species, have led him to the conclusion, that definite patterns, *i.e.*, stripes, bands, and waves of colour, vividly marked, do not occur, except in rare instances, on shells living beyond moderate depths, as below fifty fathoms or thereabouts ; and that thus we may be enabled to come to approximate conclusions respecting depths of ancient seas from the patterns preserved to us on fossil shells." The coloration is of some use in distinguishing the recent terms of Brachiopoda ; green, yellow, red, and bluish-black, being the prevailing colours : several forms are striped or spotted with red. Among the fossil species, some examples have preserved traces of their colours, as already mentioned in Part iii., p. 6, and several other examples will be hereafter noticed so that in all probability the species now extinct, when alive, presented all the rich varieties of tint, observable in the present inhabitants of our seas.—(*British Fossil Brachiopoda*, vol. i., p. 53.)

ZOOLOGY.

28. *Observations on the Habits of certain Craw-fishes.*—(In a letter of Dr R. P. Stephens to the Smithsonian Institution.) " Our friends the *Astaci* increase in interest as I become more and more acquainted with their habits and instincts. I have learned this month that they are migratory, and in their travels are capable of doing much damage to dams and embankments. On the Little Genesee, they have, within a few years, compelled the owners of a dam to rebuild it. The former dam was built after the manner of dikes, *i.e.*, with upright posts, supporting sleepers laid inclining at an angle of 4.5° up the stream. On these were laid planks, and the planks covered with dirt. The *Astacus* proceeding up stream, would burrow under the planks where they rested on the bottom of the stream, removing bushels of dirt and gravel in the course of a night. I have seen this season, where they had attempted the present dam, piles of dirt, of at least one bushel.

" They now travel over the dam in their migrations, often climbing upright posts, two or three feet high, to gain the pond above."—(*American Journal of Science and Arts*, vol. xvii., p. 134.)

29. *Arctic Whale Fisheries.*— The extraordinary success which has

attended the exertions of the whale-fishers of the United States, to which Capt. W. Baillie Hamilton called my attention last summer, has naturally roused the energies of many persons in this country, in the hope that the whales which have repaired to the farthest Arctic seas, to live there undisturbed, may yet be reached by the harpoons of our sailors.

A document communicated to the United States' Senate by the Secretary of the Navy, on the 5th of April 1852, explains clearly the very extraordinary and successful efforts, which were only commenced in the year 1848, by the whale-ship "Superior," commanded by Capt. Roys, penetrating through Behring Strait into the Arctic Ocean. The success of this intrepid sailor, who filled his vessel with oil in a few weeks, gave rise to many imitators, and in 1849 he was followed by no less than 154 sail of American whale-ships, nearly the same number going out in each of the two succeeding years. When it is estimated that the value of the ships and cargoes during two of these years amounted to no less a sum than 17,412,453 dollars, we cannot be surprised that so lucrative a trade should excite much emulation among British speculators. As geographers, indeed, we must now be anxious to have this important question finally set at rest—*i.e.*, whether (as I think, in common with Old Barentz, Capt. W. B. Hamilton, and others) there may not exist a practicable passage to the Arctic Ocean to the east of Spitzbergen; in which case our ships might reach profitable whaling grounds without the risk of a long voyage to Behring Strait and the difficult navigation of these seas.

Let us still hope that our own Government will endeavour to determine this point, so ably urged by Mr Petermann, who has shewn at how little cost and in how short a time the query could be answered, and who has also given many valid reasons to induce us to confide in the prospect of success.—(*Sir Roderick Murchison's Address to the Royal Geographical Society*, vol. xxiii., p. lxxxi.)

30. *Cod-Fishing of the Lofodden Islands.*—The cod-fishing of the Lofodden Islands is celebrated all over the north. Here, chiefly in the inclement months of February and March, fishing-boats, from an extent of coast of several hundreds of miles, are concentrated to the number, it is said, of 3000, manned by 16,000 hardy fishermen, who catch in the season not less than 3,000,000 cod-fish,* which are conveyed about midsummer to Bergen in yachts, packed in the manner already described.—(*Forbes on Norway*, p. 62.)

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* These fish are chiefly dried without salt, in the sun and wind, a process peculiar to the clear dry climate of Nordland and Finmarken.

BOTANY.

31. *Is the Flora of the Globe a distinct and independent one?* —While there are evident and distinct features in the plants which constitute the floras of different parts of Britain, there are many difficulties to be overcome before we can adopt the speculative views of Forbes. The connection between the Tertiary and the present epoch is not made out as far as the species of plants are concerned, and we are disposed to look upon the existing flora of the globe as a distinct and independent one. Schouw differs from Forbes in his explanation of the flora of the British Islands. He does not believe in the migration and geological changes to which Forbes alludes. He thinks that the west and south-west coast of Britain and Ireland had at first a mild climate, especially in winter, and that in consequence, plants were produced there common to the analogous climates of Spain and the south of France; while the Scotch and English mountains were distinguished throughout by a polar climate, and produced nearly the same vegetation as the Lapland and Scandinavian mountains.—(*Professor Balfour's Class-Book of Botany*, Part II., pp. 10–33.)

32. *Physiognomy of Vegetation in different Quarters of the Globe.*—In this department of botanical geography we consider plants according to the distribution of forms, marking the predominance of this or that form of plants by the absolute mass of its individuals, or by the impression it makes from the character given to the flora. The prevalence of a single form will often produce a much greater physiognomic effect than the number and variety of the floral productions. Hind says that a general physiognomic impression is sometimes conveyed by the prevalence of colour. Yellow colours, according to him, abound on the tropical mountain-plains in autumn, while blue colours prevail in subtropical regions. In northern latitudes and in Alpine districts, white flowers are more common than on the plains. He makes the following statements as to the proportion of colours in the flowers of different countries:

	Cyanic.	Xanthic.	White.
Central America, . .	12	30	8
Sandwich Islands, . .	12	31	7
Alashka, ...	26	13	11
California, ...	25	19	6
New Guinea, ...	12	23	15
Hong-Kong, ...	13	27	10

—(*Professor Balfour's Class-Book of Botany*, Part II. p. 99.)

33.—*The Plants considered as characteristic of Nations.* By Schouw.—In the South Sea Islands, the bread-fruit tree, and cocoanut palm supply important articles of food and clothing. New Zealand flax is characteristic of the island whence it derives its name. Among the Malays of the Indian Islands, the clove tree, nutmeg, pepper, and ginger, are the principal characteristic plants, and these are also common in India. Maize, which gives the most abundant, and also the most uncertain of all crops, was originally confined to America, which was also the case with the Potato. The Maguey plant (*Agave potatorum*), is a valuable product of Mexico, and may be called the vine of the Mexicans; while Agave americana is useful for clothing. Chenopodium Quinoa is a plant used for food in the high districts of Mexico, Peru, and Chili; the Mauritia palm is an important means of subsistence to the tribes of the Orinoco; the Date Palm is equally useful in the south of Africa, and in the Arabian deserts. The Coffee tree characterizes the south of Arabia and Abyssinia. Rice and cotton were two important plants for the Hindoos; the Tea plant for the Chinese; Wheat, barley, rye, and oats, to the Indo-Caucasian races of Western Asia and Europe; the olive and the vine for the inhabitants of Mediterranean districts; and the Rein-deer Moss for the Laplanders.—(*Professor Balfour's Class-Book of Botany*, Part II. p. 990.)

34. *The Statistics of Vegetation over the Globe.*—This subject involves the consideration of the number of known vegetable species in the world, their numerical distribution, and the relative proportion of classes, orders, genera, and species in different countries. In the present imperfect state of our knowledge of the floras of different countries, it is impossible to tell the exact number of species of plants in the globe. Those known at the present day, fdescribed and undescribed, amount probably to nearly 120,000, and rom this estimates have been made of the total vegetation, the number varying from 150,000 to 200,000. Hinds, reckoning the species at 134,000, gives the following conjectural distribution as compared with surface:—

	Species.	Extent of Surface. Geog. sq. miles.
Europe,	11,200	2,793,000
Asia,	36,000	12,118,000
Africa,	25,200	8,500,000
N. America,	14,400	7,400,000
S. America,	40,000	6,500,000
Australasia,	7,200	3,100.000
	134,000	40,411,000

The following is the estimated number of known and described plants:—

	Genera.	Species.
Acotyledonous plants, .		140,015,000
Monocotyledonous plants, .	1450	14,000
Dicotyledonous plants, .	6300	67,000
	9150	96,000

—(*Professor Balfour's Botany*, Part II., *Physiology and Classification*, p. 996.)

35. *Geographical Distribution of Plants.*—From all that has been said on this interesting subject, says Professor Balfour, we are led to the conclusion that many plants must have originated primitively over the whole extent of their natural distribution; that certain species have been confined to definite localities, and have not spread to any great distance from a common centre; while others have been generally diffused, and appear to have been created at the same time in different and often far distant localities; that migration has taken place, to a certain extent, under the agency of various natural causes; that geological changes may, in some instances, have caused interruptions in the continuity of floras, and may have left isolated outposts in various parts of the globe; and finally, that social plants were probably created in masses, that being the natural arrangement suited to their habits.—(*Balfour's Class-Book of Botany*, Part II., p. 989.)

GEOGRAPHY.

36. *Dr Barth's Discoveries in Africa.*—From the end of March to the end of May last year, Dr Overweg made a successful journey from Kuka, in a south-westerly direction, and reached to within 150 English miles of Yacoba, the great town of the Fellatahs; while Dr Barth went north-east, on a journey to Baghirmi, a powerful kingdom between Lake Tchad and the Upper Nile, which had never been previously visited by any European. Dr Barth reached Masena, the capital of the country, on the 28th April last year, which place formed his head-quarters during the three successive months.—(*Sir Roderick Murchison's Address to the Royal Geographical Society* p. 110.)

MISCELLANEOUS.

37. *Industrial Education.*—If industrial education must be cheap, in order to be successful, we may say with equal truth, that its teachers must be well paid. In these countries the worth of a man is estimated by his pay; and if we judge by this standard, the most worthless people are those to whom is intrusted the education of the people. This rule not only applies to the humble teacher of a country school, but to the most eminent professors of colleges. A simple clerk in a Government office very often receives three or four

times the amount of salary which is thought liberal for a professor of a college. If an eminent barrister is appointed to some place, less than £1000 a-year would not be offered him, and even the obscure members of the legal profession can readily obtain from £500 to £700 per annum ; but the moment a scientific man is in question, £300 is considered to be the equivalent of his services, no matter how brilliant, while the junior members are considered to be sufficiently paid if they receive a salary of a draper's assistant. We have selected the Government rewards for scientific and literary services, not because they are exceptions to those conferred by the public, but because they shew the standard by which the latter judge of the value of education ; and as long as that remains, such as it is, we can scarcely believe that the public is seriously desirous of either intellectual or industrial education. We ask of our readers to consider calmly and earnestly the above points. One false step made in the beginning would precipitate us again into the slough from which we have already made some successful efforts to escape. Let them ponder well over this fact, that to be an educated people is to be respected, to be prosperous, to be independent.—(*The Dublin Monthly Journal of Industrial Progress*, No. 11, p. 44.)

38. *The Earl of Rosse, K.P.M.A., on Education.*—" I do not contend," says the Earl of Rosse, " that science can in a moment increase our success in the arts, upon which the greatness of this country depends. If we were to say to the mathematician, give us the best lines for a ship suited to a given purpose, however profound his mathematical knowledge might be, he would fail ; practice must be combined, but in due subordination with theory. It is where in a nation science is cultivated profoundly by a large class of persons, and circumstances exist tending to direct it to practice, that some men will always be found gifted with the faculty of applying it whatever way the interests of the country may require.

Popular science, however, will not do ; it has its uses, subordinate as they are. It must be science of a high order ; science as taught at our universities. There, a power is created capable of effecting great objects, but in too many cases it is not applied at all, and it now passes away without useful results. Were it possible to enlist that gigantic power into the service of the country, by making our scientific associations more inviting, by placing science in this metropolis in a position more attractive, a result would be obtained which the meanest utilitarian would consider of immense value.—(*Proceedings of the Royal Society, London.*)

INDEX.

END OF VOLUME FIFTY-SIX.